Determining the amount of past investment property using the synthesis of cost evaluation methods

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Abstract. During its existence, each property requires specific construction operations to extend its useful life. Such construction operations and related investment are usually carried out gradually in dependence on the durability of the building materials used. To determine the overall amount of investment, a synthesis of selected valuation methods is used in this contribution. The aim of the synthesis is to achieve the most accurate result of the investment made. In selected methods used, the value of the investment made is correlated using coefficient to the price level of the investment year. The resulting investment value determined by means of the cost pricing synthesis methodology provides more accurate results than the application of a specific valuation method for the entire set of items priced.

1. Introduction

Over the years, each property requires proper care from the side of its user to be able to meet the requirements and expectations, especially in the case of a building. Apart from routine maintenance, major construction works can be divided into two groups, first of them including repairs, the second being construction works that provide the building a higher level of utility. Maintenance in its broadest sense includes a systematic activity that slows down physical wear, prevents problems, and enables to eliminate minor defects. Repairs include activities and construction operations to eliminate the consequences of partial physical wear or damage for the purposes of restoration / serviceability. The second group includes major reconstruction, modernization, extensions, superstructures, etc. Such operations mean expenditure or cost for the owner. The basic investment characteristic is the ability to increase the production in the future. The investment represents postponing the current possible consumption, that is, the exchange of the current certain value for a future uncertain value, assuming that the future value is expected to be higher than the current one [1]. The amount of investment depends on the type of specific operations (reconstruction, rebuilding, extensions, etc.); over time, the amount of the investment increases as the price level rises. The reflection of the investment made in the usual price of the property (usually a building) is called appreciation or depreciation.

In general practice, there is no relationship, either synergistic or disjoint, between the amount of the investment made and the level of appreciation/depreciation. There are investments having a negative impact on the usual price or property, it can be for example the application of significantly unusual...
colours on the façade, etc., that is, changes specific for one user, but generally not accepted positively. In terms of the valuation purpose, it is necessary to define precisely the subject of valuation, i.e., whether the subject of valuation is the original investment (expenditure) or their reflection in the usual price of the whole property (appreciation). Furthermore, it is recommended to define the valuation date and the relevant price level, which implies the necessity to deal with the time lag between the valuation date and the date of assessment processing.

In the event that a property where the construction investment has been made is a subject to dispute of two parties that used the property jointly in the past, the subject of valuation is the investment made for the period of the joint use. The following text will deal with the valuation of the original investment (expenditures) in the construction operations of a house.

In the standard situation, in order to determine the value of the valuation object – investment in the selected construction works of a house, usual valuation methods without their adaptation can be used. The basic valuation methods include income capitalization method, cost approach, and sales comparison approach. The cost approach will be dealt with in more detail in the following text. In order to increase the result accuracy, it is possible to carry out the adaptation of one method or a synthesis of several valuation methods or sub-methods.

The objective of the contribution is to determine the current value of investment property using the synthesis of selected procedures and to apply the methodology created to a specific model case.

2. Literary research

The property, or more precisely, buildings, is a special category in economic and technical fields, which is given by their specific properties from both perspectives. In technical fields, these properties are determined by the materials used in their construction, as well as the level of technology in their processing and in the construction. From the economic perspective, property is a specific area for the purposes of determining the value. The determination of the value of subsequent modifications, reconstruction, and general investment made is a separate chapter. Although there has been many years’ research in this field, it cannot be considered fully explored in any respect.

All building materials are subject to wear due to ageing. As a result, slip and shear forces accumulate in the material at the microscopic level, and they are released in the form of cracking. Material fatigue rate and speed are given by the number and intensity of acting of the forces causing the accumulation of slip and shear forces in the material [2]. To minimize the impact of material fatigue stress, various additives are created to improve its mechanical properties. Most additives are developed for metal and metal alloys constructions. These additives enable to increase their hardness, strength, and resistance to bend and compression especially of metal materials. A great advantage of these additives is their ability to suppress the propagation of crackings or other material defects [3]. Metals and their alloys consisting of the purest fine-grained materials are more resistant than the alloys containing a higher share of substances negatively affecting mechanical properties of resulting alloys [4].

With the increasing age of buildings, energy intensity of their operation increases as a result of energy leakage through fatigue-deformed materials the buildings are built of. Using statistical methods, a strong relation was found between the energy consumption, building age and buildings’ compactness. New technologies and reconstruction techniques are being a developer to restore the original energy performance of buildings [5]. Attention was drawn to the risks of moisture and biological damage to the buildings whose construction materials have lost their integrity. Therefore, a model to a monitor mould growth and moisture propagation depending on the degree of the material damage have been made. It is an efficient tool for evaluating the durability of various building
Building materials and the speed of their fatigue or damage is influenced by the climate. For this reason, the requirements for increasing their resistance to climatic influences are imposed on building materials [7].

A very important step before the construction of any building is the preparation of the whole project. In this stage, the chosen material is the main factor influencing the construction costs. For this reason, the detailed planning work of the whole construction, including its financing, is carried out. The preparation of the whole project includes financial costs as well as time required for the construction. However, these determined limits are very difficult to comply with. Therefore, the case-based reasoning model was created, which is a hybrid model of predicting the duration of the construction and the construction costs. Using this model, it is possible to predict these aspects at an early stage of the project. It is a combination of analytical thinking, forecasting using artificial neural networks, and Monte Carlo simulation [8]. Monte Carlo simulation procedures were simplified and a solution was proposed which enables to forecast real time development of building construction costs [9]. It is possible to use the construction cost index for measuring the development of construction costs [10]. The efficiency of this index was extended by linking with the integrated vector regression. In this way, it is possible to minimize the risk of an unexpected increase in the costs of construction completion [11].

In practice, cost models for building construction are created only based on the experience and intuition of experts specializing in this activity. In a scientific sphere, forecasting of such costs using artificial neural networks created on the basis of historical data is being increasingly used for this purpose [12].

Construction projects managers have to deal with a number of obstacles. These are problematic factors represent a risk for the resulting project from several perspectives. The riskiest factors with the greatest negative impact on the implementation of the whole project are those acts at an early stage of the construction project. Using the Friedman and Wilcoxon test, time, cost budget, and quality have been identified as the riskiest factors [13].

However, over time, it is not possible to avoid the necessary costs of building reconstruction and repairs. Rebuilding and extensions create a separate category of investment costs. Some authors dealt with the determination of the overall costs of constructing specific types of buildings. For example, Lovering, Yip and Nordhaus [14] dealt with the determination of the costs of constructing nuclear power plants. This particular research was related to the growing trend of their construction over time. In general, the overall costs of construction project implementation increase with time. This relation, however, has not been confirmed in the case of a specific type of property. Cantarelli et al. [15] examined the effect of exceeding the length of planned construction work in transport construction projects on the change in the amount of precalculated costs. They found that in the area of transport infrastructure construction, the costs of its completion increase by five percentage points per each year of delay in the completion of the construction process.

Investment and the related risks were investigated also by Hašková [16]. Investment in a future project carries several risks. These risks are mostly related to the uncertainty of the outcome of the planned investment project. Property valuation and the impact of the individual factors on the price was addressed by Horák and Krulický [17]. They concluded that the locality in which the property is situated has a very significant influence on its value. An undesirable and problematic locality can thus decrease the value of the property situated there. In the case of investing in such a property, its required appreciation by this investment cannot be expected.
3. Theoretical background

For the valuation of property, several methods can be used. They can be divided into three groups: income capitalization method, cost approach, and sales comparison approach. With regard to the objective specification of the contribution submitted, the focus will be on the cost approach.

Sales comparison approach can be used if there is a sufficiently large set of comparable objects available, which have the same or similar parameters as the subject of valuation has, and for which they required information necessary for comparison is available. Sales comparison approach expresses a general view of the subject of valuation without considering future operation (income capitalization method) or cost of acquisition (cost approach). However, it would be a mistake to claim that the value determined by means of a market comparison does not reflect both factors mentioned above. These factors are considered by the buyers in the market, and are thus reflected in the resulting price. Nevertheless, since the buyer as an independent living entity represents a sort of black box for their decisions, it is very difficult to determine the weights of both valuation methods. Sales comparison approach thus expresses the situation of supply and demand for a given subject of valuation at a given moment in the market.

Income capitalization approach is most frequently used in order to measure value, the monetary benefits that the subject of valuation generates to its owner. In terms of property, this situation occurs especially when renting commercial premises used for business activities. Income capitalization approach is thus future-oriented and focused also on the quantification of future benefits from holding the property. Cost approach represents the cost incurred to acquire a given building or perform a construction work. By its principle, cost approach cannot be used independently for land valuation but only when combined with other valuation methods. Considering the fact that the cost approach shall express the costs incurred to acquire a given property (building), it is the best means of determining the value of investment property. The cost approach includes the method of the sum of actual costs incurred, valuation method at the level of budget costs, method of requesting quotations from companies specializing in providing material, assembly, and related services in the fields whose products or services are the subject of valuation, and the valuation method using price regulations [18].

The method of the sum of actual costs incurred is conditioned by the existence of supporting documents proving the number of financial investments for individual construction works. Basically, it is not a new valuation method when the value of the subject of valuation is not known, but rather a secondary source of information and its verification. In terms of accuracy, it is the best valuation method. By the sum of the documented investment, it is possible to determine fast and precisely the overall amount of investment made together with the date of execution of the required operations. The disadvantage of this method in valuation consists in a very frequent absence of these supporting documents (invoices paid).

The valuation method at the level of budget costs consists in financial expression of individual items necessary for carrying out the required works together with the extent of the necessary work. It is a very precise valuation method, which can be used for the valuation of partial investment in property, and it is generally used for budgeting of buildings. Within this method, an inventory of individual material items is made in the required quantity (bill of quantities) with their financial expression and the overall price of the subject of valuation is determined based on the sum of all these items. The expression of budgetary costs is usually based on the price system for a given market. In the Czech Republic, the price system of construction costs is regularly issued by URS CZ a.s. and RTS a.s. The disadvantage of this valuation method is the labour and time necessary to achieve the resulting value. Another disadvantage for occasional users can be the considerable cost of the approach to the price systems of both companies.
Another method for determining the value of investment is the method of requesting quotations in selected companies offering the same or similar products and services to those which are subject of valuation. The use of this method consists in comparing quotations of selected companies to carry out or supply a given subject of valuation. Based on the obtained quotations and their average, the usual value of the required investment to the date on which the request was made is determined.

The last option is to use price regulation [18]. This method is based on the price system set by legislators when adopting a given law. The price system is then regularly increased by the value of price level growth. Great universality of this method is both an advantage and disadvantage; its application is thus possible even when there is only limited input information about the construction works implemented. Its advantages include its easy application without the necessity to own special SW. This method is mostly used in the cases where it is not possible to determine the value of the investment made in any other way due to missing data. Another advantage is an easy calculation of the individual investment items since this procedure is defined in the relevant decree. For the calculation of the investment value, a relevant annex to the degree sets the base price per m³ of built-up space by the relevant type of buildings, which are divided into the categories A-O. Furthermore, individual coefficients are applied to the base price: coefficient of base price conversion by the type of building (K₁), coefficient of base price conversion by the size of the average built-up area of a building storey, or separately valued part (K₂), coefficient of base price conversion by the height of a building storey, or separately valued part (K₃), coefficient of a building equipment (K₄), position coefficient (K₅), and coefficient of change in building prices (Kᵢ). The methods for determining the values of all these coefficients are also specified in the annexes to this Decree. The choice depends on the type of building and the layout of a specific property. In the case of evaluating a house using this valuation regulation, only coefficients K₄, K₅, and Kᵢ are used. Using these coefficients, the base regulated price is determined by the multiplication of base price and the total built-up area in m³, which is determined based on the dimensional proportions of the property being valued. Subsequently, the budget of the resulting value of the property is made for the percentages of individual structural elements and the interior equipment of the property. The percentages are also set by the Decree. The disadvantage of this valuation method is the outdated volume shares of individual structural elements. During the effect of the Decree, modern construction systems have been developed, and materials with better physical properties started to be used, and significantly different technologies and accessories have been installed in buildings. Unfortunately, the valuation decree has not been able to react adequately to this dynamic development in the building industry. This method is thus used only marginally in practice, and only in the cases when it is not possible to determine the value of a particular structural element of the property using other valuation methods.

4. Materials and methods
In the case of determining the value of construction works performed in a model property, it is necessary to carry out a synthesis of all the aforementioned methods. The resulting value of all investments made will be calculated as a sum of all results achieved. The individual methods mentioned above will be ordered according to the level of the accuracy of the results that can be achieved by their application. This order is determined mainly by the availability of the supporting documents that are available for the valuation of the investment made. The unavailability of the supporting documents for some types of investment is the reason for using another less accurate method that can be used without the necessity of the input data from specific supporting documents. The accuracy of a specific method is directly proportional to its methodological demands and stricter requirements for the input data. The application of the valuation method using the price regulation [18] is methodologically and numerically undemanding, and no specific supporting documents that would be difficult to identify and consider at the valuation date are necessary. On the other hand, the application of the valuation method using the sum of the actual costs incurred is strictly conditioned by the availability of specific, often historical supporting documents that contain all necessary
information for the application of this valuation method (invoices paid). These documents are difficult to obtain in some cases. The difficulty of the valuation method used usually increases with the time lag between the investment implementation and the date of valuation. When choosing a specific valuation method to be used in a specific investment case, it is thus necessary to consider the ratio of difficulty and accuracy of the result.

The synthesis of the methods will be demonstrated on a model case of a specific property. In the case of using the valuation method using the price regulation [18], there will be determined the value of a built-up area in m$^3$ on the basis of the external dimensions of the model property. First, a list of individual construction works carried out on a model property will be made together with the specification of the year in which the construction works were performed. At the same time, the most suitable valuation method will be chosen based on the availability of a particular investment.

In the case of the application of the valuation method at the level of budget costs, requesting quotations in companies specialized in providing material, assembling, and the related services in the field whose product or service are the subject of valuation, and the valuation method using the price regulation [18], the investment made will be converted in the price level of the year in which the investment was made using the conversion rates according to URS CZ a.s. However, the price coefficients will not be applied when using the sum of the actual costs incurred, since these investments were made at the time of the performance of the construction work.

The model property will be a house consisting of a single dwelling unit built in the 1930s. Between 1992 and 2005, construction works were carried out including a set of necessary reconstruction works. Furthermore, before 1992, another wing was added to the model property, which also required certain investment in its reconstruction. This model property includes a secondary building in the form of a single-storey building, which is used to store gardening supplies for the maintenance of the adjacent garden space. The model property will be divided into three parts: the house, the added wing, and a single-storey building used to store gardening supplies and machinery. The supporting material for determining the value of the investment made will be the documents and instruments available proving the amount of remuneration with the date of realisation of the investment (issued invoices for the material and services, evidence of payment of the liability, etc.).

5. Results
When addressing the objective of this contribution, first a list of individual investment in each part of the model property was made. For each of the investments made, the best alternative of the used cost valuation approach was determined. Table 1 represents a list of investments made in the first part of the model property (a house) with the selected valuation method and the year of the investment realisation.

| Type of investment                        | Valuation method used           | Year of investment realisation |
|------------------------------------------|---------------------------------|--------------------------------|
| uPVC windows                             | Sum of actual costs incurred    | 2018                           |
| Reconstruction of indoor staircase        | Requesting quotations           | 1999                           |
| Installation of outdoor thermal insulation| Itemized budget method          | 1999                           |

In order to determine the investment in the uPVC windows, supporting documentation was available, which contained precise information on the amount of investment and the date of its realisation. Therefore, for determining the value of an investment in this item, the method of the sum of the actual costs incurred was used. In the case of reconstruction of an indoor staircase, the method of requesting quotations from companies specializing in providing material, assembly, and the related
services in the field whose products or services are the subject of valuation. In this case, it was not possible to use the method of the sum of actual costs incurred due to missing necessary supporting documentation. Itemized budget method could not be used either since in the itemized budget, there are no data for the calculation of the costs of the indoor staircase construction. Determining the investment in outdoor thermal insulation was carried out based on the itemized budget method since this method has been evaluated as the most precise method of determining the value of an investment with respect to the supporting documentation available.

The list of investments made in the second part of the model property, which consists of added wing, is shown in Table 2 together with the selected valuation methods and the year of investment realisation.

| Type of investment                        | Valuation method used               | Year of investment realisation |
|------------------------------------------|-------------------------------------|-------------------------------|
| Reconstruction of electrical wiring      | Valuation Decree 441/2013 Coll.     | 1992                          |
| Reconstruction of water distribution systems | Valuation Decree 441/2013 Coll.     | 1992                          |
| Sewer reconstruction                     | Valuation Decree 441/2013 Coll.     | 1992                          |
| Replacement of entrance door             | Requesting quotations               | 1992                          |
| Replacement of floor covering            | Sum of actual costs incurred        | 2018                          |
| uPVC windows                             | Sum of actual costs incurred        | 2018                          |

In the case of construction work performed (reconstruction of electrical wiring, reconstruction of the water distribution system, sewer reconstruction) in the added wing to the model property, no supporting documentation enabled to determine the value of the investments. Therefore, the application of the method of the actual costs sum incurred was not possible. In this particular case, these were construction works, the execution of which was, in terms of the amount of material used, hidden under other layers of related construction works carried out subsequently. The impossibility to determine the amount of the material used was the main reason for the impossibility to apply the itemized budget method in these cases. For the same reason, neither the method of requesting quotations from companies specialized in providing material, assembly, and related services in the field whose products or services are the subjects of valuation. The remaining and thus the only method applicable in terms of the supporting documentation and information was the valuation method using the price regulation [18].

The list of investment made in the third part of the model property consisting of a separate single-storey building used for storing garden equipment and machinery is shown in Table 3 together with the selected valuation method and the year of investment realisation.

| Type of investment                        | Valuation method used               | Year of investment realisation |
|------------------------------------------|-------------------------------------|-------------------------------|
| uPVC windows                             | Requesting quotations               | 1992                          |
| Replacement of entrance door             | Requesting quotations               | 1992                          |

In the case of investments made in the separate single-storey building for storing garden equipment and machinery, for all investment cases that were the subject of valuation, the method of requesting quotations in companies specialized in providing material, assembly and related services in the field was applied. Due to missing supporting documentation, it was not possible to use the method of the sum of actual costs incurred. Itemized budget method cannot be used due to the absence of the valuation methodology for this type of investment.
Furthermore, specific quantification of the individual investment made in all three parts that form the model property. In the case of investment in the reconstruction of a house, the amount of investment in the installation of uPVC windows was determined at CZK 52,811 on the basis of the sum of the actual costs incurred. The amount of investment in the reconstruction of the interior staircase was determined using requesting quotations at CZK 100,640. The amount of investment in the installation of outdoor thermal insulation was determined using the method of itemized budget. For the price level of the year 2018, the amount of necessary investment in the material was determined at CZK 25,186 and the costs related to the assembly was determined at CZK 1,828. The total amount of investment in the outdoor thermal insulation was thus determined at CZK 27,014. The sum of all investment in the house determined by means of various methods, the overall amount of the investment realised was found out. At the price level of the year 2018, the total amount of investment in the house was determined at CZK 127,999.

Subsequently, the amount of investments in the previously added wing was quantified. In order to determine the amount of investment in the reconstruction of electrical wiring, water distribution system and sewer system, the methodology specified in Annex 11 to the Valuation Decree [4], as for determining the value of the investment in these items, no supporting documentation was available. First, the area of the added wing build-up space was calculated on the basis of its external dimensions. The calculated area was 270.31 m². Subsequently, the base price per m² of the build-up space was determined according to the data in Annex 11 of the Decree. Then, the coefficients for final modification of the base price per m² of the added wing built-up space were used, including the coefficient of building equipment (K₄), position coefficient (K₅), and the coefficient of change in building prices (Kᵢ). Following the application of all these coefficient, the base modified price per m² of the added wing built-up area was determined at CZK 4,329.20. The total price of the added wing including all equipment was determined at CZK 1,170,226 (4,329.20 * 270.31 m² = 1,170,226). On the basis of other methodological instructions specified in Annex 21, the total price of the added wing was divided according to the percentage of structures and equipment stipulated in the Decree. The amount of investment made in the reconstruction of electrical wiring was determined at CZK 46,582, in the case of the reconstruction of the water distribution system it was CZK 34,085, and CZK 31,812 in the case of sewer reconstruction.

In addition, the amount of investment in the replacement of the entrance door was determined using the method of requesting quotation at CZK 46,113. The amount of investment in the replacement of the floor covering was determined at CZK 170,143 using the sum of the actual costs incurred. Similarly, the amount of investment in the installation of uPVC windows was determined at CZK 99,683.

Subsequently, the amount of investments in the separate single-storey building for storing garden equipment and machinery was determined. The investment included the installation of uPVC windows (the amount was determined using the request for quotations in companies specialized in selling and assembly of uPVC windows). The offer prices of these works were averaged in order to achieve the most accurate price possible. On the basis of this method, the amount of investment for this item was determined at CZK 8,376. The second investment in terms of the reconstruction of the building was the replacement of the entrance door. Here, the amount of investment was determined using the average offer prices of specific companies engaged in their selling and assembly. The amount of investment was determined at CZK 18,839 in this case.

After that, the correction of the amount of investment made in the model property before the year 2018 was carried out in order to achieve the price level of the year of the investment realisation. Conversion coefficients were taken from URS CZ a.s. The coefficient for determining the price level for buildings was converted from the 2018 price level to the 1992 price level of the year 1992 was
0.25. In the case of residential buildings, the coefficient for converting the price level from the year 2018 to that of 2019 is determined at 0.229, and in the case of converting the 2018 price level to 1999 price level, it was 0.589.

After the application of all the aforementioned coefficients, the amount of investment was determined in accordance with the relevant years of investment realisation at the amount of CZK 461,357.

6. Conclusions
Determination of the amount of investments made in the past was carried out by means of a synthesis of selected methods. Investment requiring valuation was demonstrated on a model case. When selecting a specific valuation method, the availability of supporting documents for the application was considered, along with the difficulty of their acquisition. The selection of individual methods applied was also based on the nature of the investment subject. The synthesis of selected methods resulted in obtaining a more precise result of the quantification of the amount of investments made than would be achieved if only one method was used.

In determining the value of an investment with a greater time lag, when using the valuation method at the level of budget costs, requesting quotations from companies specialized in providing material, assembly, and the related services in the fields whose products or services are the subject of valuation, and the valuation method using the price regulation [18], conversion coefficients which are registered and issued by URS CZ a.s. were used.

Further research in this field could be aimed at identifying other cases in the area of investment valuation and exploring other applicable methods for future more precise determining of the amount of investment made in the near and distant future.

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