Applied Mechanics and Materials Vols. 357-360 (2013) pp 2207-2214
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doi:10.4028/www.scientific.net/AMM.357-360.2207

Maintenance, building depreciation and land rent

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Keywords: maintenance, depreciation, land rent, obsolescence.

Abstract. This paper aims to explore three closely related issues: building maintenance, building depreciation, land rent. What makes these three issues deeply connected is the market value of the property. The choice to carry out preventive or corrective maintenance depends on how the building is affected by age (physical depreciation) and on the trend of land rent. Physical depreciation and land rent are phenomena that act with opposing force in determining the market value of an asset. Because the maintenance is strongly influenced by this value, it becomes crucial to identify the factors that cause it. The combination of the dynamics of two phenomena can (or not) make convenient maintenance. The right interpretation of the correlations in these problem areas can support a better property management / maintenance by owners, managing agents and related parties.

Introduction

The importance of properties' depreciation in tax and social policy choices [1,2,7,8,23] justifies the regular interest of the research on this issue. Several studies, using econometric models and assuming the age of the buildings as a proxy of the depreciation, tried to estimate its annual rate [17]. The results showed, however, not negligible differences from one study to another. As often pointed out, the variability of results is certainly due to the use of different measurement methods, the differences in the real estate markets investigated [2] and to the periods of analysis. However, we specify that these deductions refer to the market value of the entire property. The literature [3,4,22] states that the depreciation represents the decrease in time of the building utility and therefore the equivalent loss of value, measurable in the course of its useful life starting from the date of construction. This parameter is different from the depreciation determined by the cost of construction (not the land). There is a difference, in fact, between *economic depreciation* and *physical depreciation*. Economic depreciation refers to the fluctuation of market value of the property. Physical depreciation is expressed as loss in value from the cost of new, caused by *physical deterioration* and *functional (or technical) obsolescence*.

From an economic point of view, the physical deterioration may be differentiated on the base of two factors of depreciation: *the age*; *the income decay*. Depreciation due to age is the consequence of the fact that a building or its component, regardless of its economic benefits, in comparison with a corresponding new, has a shorter efficiency life span. The reduction due to income decay is the effect of the lesser utility of an asset already in use compared to the corresponding new. The lesser utility is given by increasing operating costs, along with an even higher frequency of extraordinary maintenance [20].

The functional (technical) obsolescence is due to changes in technology (i.e. in system design, materials used, or to poor compliance to new standards of quality) as well as to introduction of technological innovations, that have lower operating costs and / or higher efficiency.

The physical depreciation can also be distinguished in *curable* and *non-curable*. Curable physical depreciation is a loss in value retrievable with an intervention whose cost is less than the building increased value; non-curable depreciation occurs when intervention's cost is higher than the generated value.

The urban land covered by a building normally does not suffer any depreciation over time; even more its value could increase due to the land rent. It is therefore necessary to make a clear distinction between the land rent and the building (or building part) depreciation. These factors influence different components of the property's value, whom usually interact with contrasting effects. Because the aforementioned literature refers to the economic depreciation as the overall reduction of property's value, the problem of estimating (also influenced by the land rent) is overcame introducing, among the factors of real estate depreciation - more than those relating to the built - also the *economic (or external) obsolescence*.

The economic obsolescence originates from environmental changes, from changes of the particular real estate market conditions, from changes in the economy in general, and do not originates from phenomena which affect the technological and physical characteristics of the building. Usual phenomena originating economic obsolescence are: increase of vehicular traffic, worsening of surrounding properties conditions. These changes relate to extrinsic characteristics of the property, which adversely affect the demand for real estate. The reducing effect on property's value attributable to such features involves all those goods located into a homogeneous market area. In other words, this is not obsolescence of building, but obsolescence of the land on which it insists.

Therefore it must be absolutely rejected the idea of those who say, «The loss in value due to external obsolescence must be attributed in proportional parts to the land area and to the building». The literature, which we have referred [5,6,7], seems to overlook the fundamental effects of land rent on the total value of a building. It does not distinguish the evolutionary dynamics of the property's value between the two inputs: the land and the building. In this paper, "depreciation" means a reduction in value due to increasing age, decay, natural wear and tear, or functional obsolescence of a fixed asset.

External obsolescence vs. depreciation

Empirical research conducted on market values and econometric processing show that the function of economic depreciation is not monotonically decreasing (Fig. 1).

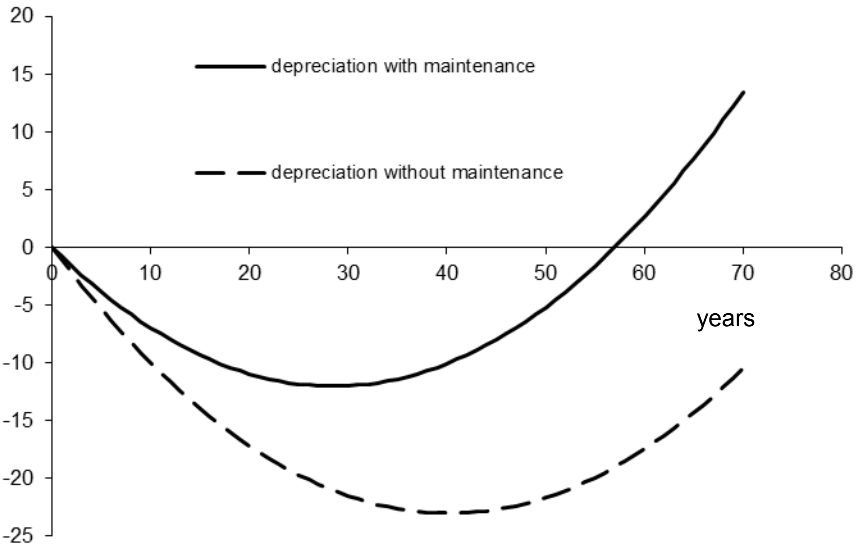


Fig. 1 - Change in depreciation rate for residential properties related to the level of maintenance (source from Wilhelmsson).

As the chart shows, in particular, the economic depreciation stops at a given point in the life of the asset, and the trend of the value reverses its course to become growing. Referenced studies [5] do not provide a precise scientific explanation of the phenomenon, but they attribute the turnaround of the value to a so-called *vintage effect*: «It seems that very old properties have a premium attached to the price, because of charm, exclusivity and quality of construction», therefore, for physical characteristics of the buildings connected at the time of construction. In reality, the vintage effect alone cannot explain the reversal in the trend rate of economic depreciation illustrated by the graph in Fig. 1. Along with this effect a decisive factor in the trend increasing over time becomes the phenomenon of *land rent*.

For better clarification, Fig. 2 shows the property's value curve, as the sum of the rates for the land and built. The increase of land value is higher than the depreciation of the built part, so it counterbalances depreciation. The change in this latter part is, in particular, not linear, has concave shape, as reported by several empirical studies [8,9]. The intersection between the curve of land value (low to high) and the one describes the function of the total value (A + C), which is subtracted from the cost of demolition, marks precisely the demolition threshold is reached. The maintenance action undoubtedly plays a key role in the definition of the buildings depreciation. On the other hand, the maintenance is strongly influenced by the dynamics of the overall value.

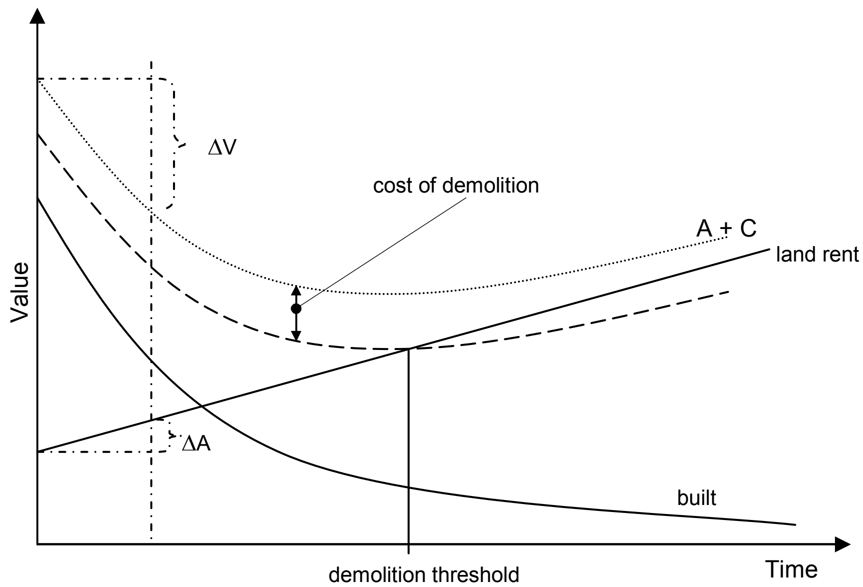


Fig. 2 - Value of a property

Maintenance, building depreciation and land rent

There is a very strong relationship between depreciation and maintenance. Well-maintained property shows depreciation rates much lower than properties poorly maintained. Chinloy [15] argues that the depreciation rate is double in the absence of maintenance. Knight and Sirmans [6] analyzing a sample of 775 transactions of residential property in a great neighborhood in Baton Rouge, Louisiana, in the 1985-1993 period at the 18-th year of age (the average of the sample), measure the effects on the depreciation by different levels of maintenance.

The results show depreciation rates of 32.8%, 21.1% and 19.1% respectively to levels defined as "bad, good and excellent." Harding, Rosenthal and Sirmans [16] for single-family housing, estimate that the annual depreciation rate increases by one percentage point in the absence of maintenance (i.e. jumps from 2% to 3%). Springer and Waller [17] determine the variables that provide the greatest contribution in explaining the variability of the maintenance costs of residential buildings for rent. This research shows that the maintenance expenditure per unit area increases with increasing age of the property, with the rise of tenant turnover and prestigious character building. Apartments for rent have also rising costs of maintenance per square meter, if it is greater their ability to generate income.

British Standard (BS 3811: 1964) defines maintenance as «a combination of any actions carried out to retain an item in or to restore it to an acceptable standard». The Committee on Building Maintenance (1972), in UK, defined maintenance as «the work undertaken in order to keep, restore or improve every facility, i.e. every part of a building, its services and surrounds to a currently acceptable standard, and to sustain the utility and value of the building». In Italy the UNI (1996) encode maintenance as a combination of actions to «ensure the use of the property, maintaining its asset value and its initial performance within acceptable ranges for the whole useful life, promoting the technical and normative adjustment to initial or new performance selected by the manager or to meet legal requirements».

The last definition clarifies that the maintenance includes those actions that alter the functional characteristics and physical properties of the building, namely those improvements that are needed - without implying significant changes in the use or performance changes - to keep satisfactory quality levels during the economic life of the good. The performance-quality levels, so-called quality standards, define the acceptability thresholds of building quality. They are influenced by factors such as: socio-economic changes, land transformation, technological innovation. Rapid socio-economic changes require some careful thought about how to differentiate the resources available to meet emerging needs (i.e. change of housing models to meet ever increasing demands). Land transformation determines changes in the economic system, making specific maintenance policies more or less convenient. Fast technological innovation in the building sector, marks the introduction of even more competitive components, both from a performance point of view, and from a costs/benefits balance of the service offered. Socio-economic changes and land transformation affect the land rent. Most of the increase of the quality standard is generated by what determines also the land rent. We may think that the land rent and the growing demand for quality are the same thing. At the end of the economic life, we will proceed with a redevelopment or demolition and reconstruction [11].

In general, the decision to carry out an expenditure on maintenance obeys the common economic principles, it responds to a measurement method that has the objective of profit maximization. The key references of this evaluation are the real estate market and the value drivers. Without demand, it would have no economic sense to talk about the maintenance costs and standard maintenance. While in an active market the problem is the estimation of maintenance contribution to the formation of real estate value, compared to other interacting factors [12]. This means that we need to understand the real relationship between the cost of maintenance and the economic benefit that result from it. So far it is appropriate to estimate the value of maintenance programs, analyzing them in financial terms. The financial constraints, the steady increase of maintenance expenditure and energy, maintenance environmental implications, induce (or should induce) even more public and private institutions to carefully consider the importance of an efficient management of assets and resources [10]. Although most of property owners perceive the usefulness of maintenance, the decision to undertake maintenance of a building comes from conveniences of the moment and, as often happens in condominium, it is the result of random compromise between the demands of intervention and the availability of financial resources.

It is also useful to remember that the assessment about the appropriateness of maintenance, since it is specifically valid, should be defined on the characteristics and attitudes of the person who requests it. For example, the setting of a threshold of acceptability (standard maintenance) is essentially subjective, when referred to quality or aesthetic parameters. The decay of the finish does not affect - at least in a direct way - the performance of the manufactured housing; however, we can assume that high quality standards building façade’s finishes (let us think to a company’s office building), promotes image and generates indirect benefits.

A method to support investment decisions in maintenance is the evaluation of the more profitable Life Cycle Cost [19], i.e. the total cost that comes from owning and using a property over the expected lifetime. In economic terms, the Life Cycle Cost (LCC) is the Net Present Value of all the costs incurred by the building in a given period of analysis: starting from the design phase until his retirement. The expenditure on maintenance, given by the costs of *preventive maintenance* (aimed to reduce the probability of deterioration and to avoid future restoring costs) and *corrective maintenance* (aimed to repair and replace damage already occurred); it must be added to the expenditure on technological and functional improvements. This last one can cover important rate (about half) of the total LCC.

Maintenance generally implies and presupposes an improvement of the building’s performance that increases income potentiality and consequently the property’s market value. Evaluation of maintenance profitability should require the identification of the following terms:

- actual maintenance expenditures;
- cost of repair / corrective maintenance;

- cost of building's components replacement;
- useful life of replaced components;
- expected economic effects of maintenance, along the property life;
- frequency of repairs, and/or replacements required for not maintained parts;
- effects on earnings and/or lower operating costs, and/or avoided losses due to life downtime caused by poor maintenance.

Most of the variables involved are not readily quantifiable, because they relate to very far future events. This explains the belief of many about the poor reliability of the LCC Analysis. In particular, the greater uncertainty characterizes the evaluation of the effect of maintenance on the economic life of the property. This effect is closely connected to the factors that affect land rent (urban transformations and any changes to the context), as well as the factor 'innovation' introduced by the technological advancement in the construction sector, and the consequent new functional or aesthetic needs.

For other parameters involved in the evaluation of convenience to carry out maintenance, there are cases with databases that provide albeit with some limitations highlighted below, information on data's probability. These parameters determine the effective maintenance expenditures and the optimal frequency [13]. The calculation of the maintenance expenditures should also include the expenditures for other routine works. They count less and do not have a temporal regularity. For them it can be assumed a constant expenditure per annum.

The estimation of actual maintenance expenditures is objectively hard in relation also to:

1) the very long average life of the components maintained; that makes hard acquiring data in satisfying amount able to be treated in probabilistic terms;

2) the high variability of the useful life and the frequency of maintenance depending on the use of parts (or the entire building), and environmental conditions;

3) the continuous innovation in construction techniques and materials (in restoration and maintenance), that makes a prediction uncertain about the new components' life duration.

With regard to the optimal frequency of the maintenance, we should pay attention on the concept of acceptable standard. Lee [13] comments that an "acceptable standard" may be construed as acceptability by the person paying for the work, or by the person receiving the benefit. There are actually two processes envisaged: "retaining" and "restoring". Retaining is the maintenance work carried out in anticipation on any failure (preventive maintenance). Whilst restoring (repair or replacement) is the work carried out after a failure (corrective maintenance). If we assume a linearity or anyway a regularity defined by a function (even non-linear) in the phenomenon of degradation of the quality and / or the performance of the component, the lower threshold, that determines the necessity of maintenance, marks the transition to a condition of increasing probability of a failure or of a rapid decay. This latter condition would lead to higher overall costs due to a delayed of maintenance or repair (Fig. 3).

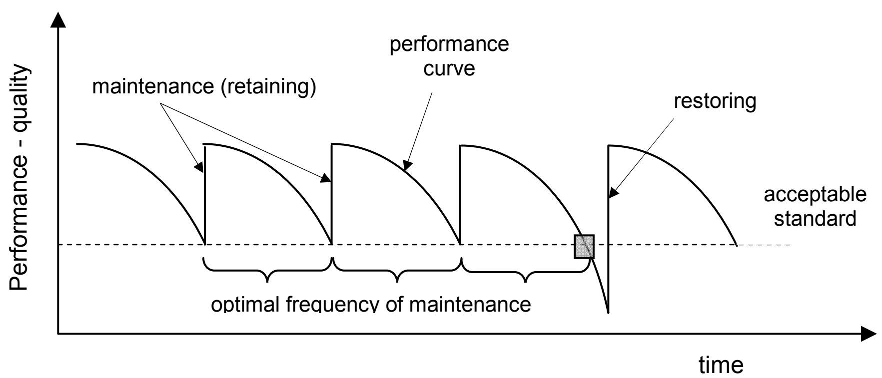


Fig. 3 – Quality level of a component building subject to periodic maintenance.

However, the graph of Fig. 3 does not represent all the possible behaviors of the building components: indeed some of them may maintain constant performance capacity during the entire life cycle, for others it can be imagined that along the time occurs a progressive raising of the minimum acceptable standard required by the users.

A closer situation to the reality is therefore represented in Fig. 4; it shows the physical life (without maintenance), the functional life (life in service) and the useful economic life.

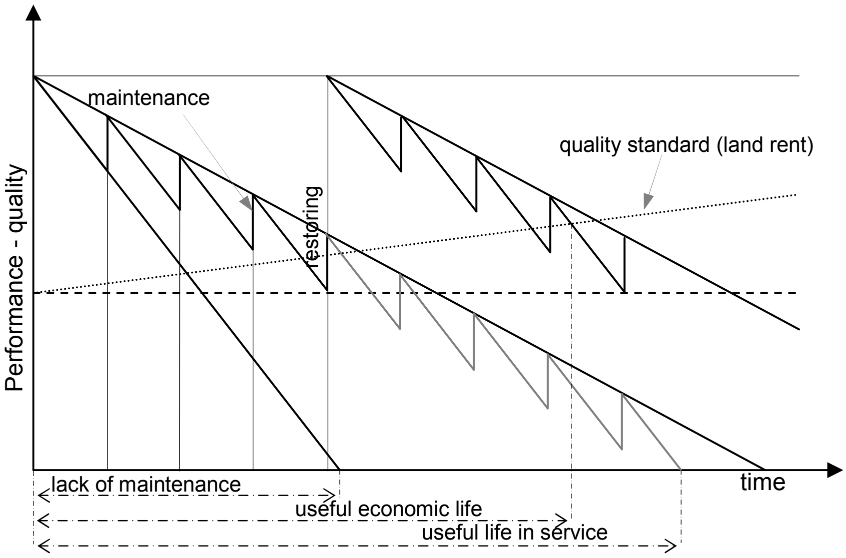


Fig. 4 – Variation in performance of a component building according to various hypotheses of work.

The graph is constructed assuming that:

a) the new building component has a quality level and performance capability higher than the acceptable standard;
b) the steady growth of this minimum along the time;
c) a gradual decay of the considered component.

The need of maintenance must therefore be assessed regarding to:

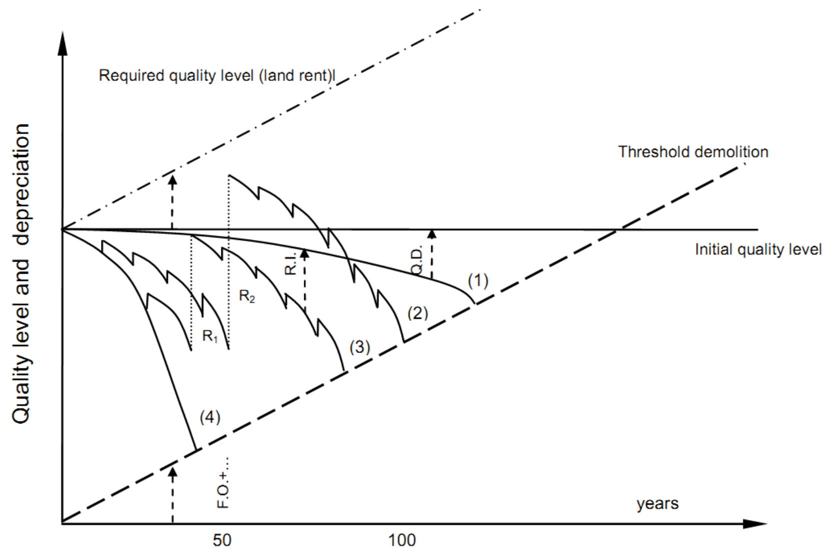
1) some physical characteristics (the type of material, the level of modularity and accessibility to the component);
2) the dynamics of the process of degradation;
3) the functionality in relation to possible changes in the environment (innovation, changes in the needs of users).

The difficulties mentioned for the determination of the parameters involved have discouraged theoretical studies on the duration of the service life of building components. However, in the literature some research has developed long-term observations on a very large number of systems and subsystems of the building artifact whose results provide a useful reference in the assessments of the maintenance costs [14].

Conclusions

Although the relationship between depreciation and maintenance expenditure has been well developed theoretically, few empirical studies quantify that relationship. This is due to the lack of adequate and structured data.

The statements of this work are effectively synthesized in the graph of Fig. 5 that is a reworking of the one proposed by Bezelga and Neto [18]. It provides a useful comparison of the different factors of depreciation and their classification.



F.O. = Functional (technical) Obsolescence
I.D.. = Income Decay - curable
Q.D. = Quality Deterioration due to the income decay incurable and physical deterioration;
(1) = Evolution with very frequent maintenance;
(2) = Evolution with periodic maintenance, restoring and modernization (R2);
(3) = Evolution with periodic maintenance, with restoring (R1) but without modernization;
(4) = Evolution with no maintenance.

Fig.5 - Depreciation of the buildings according to the type of maintenance (rework by Belzega and Neto)

In particular, it well illustrates how fundamental are maintenance and modernization to prolong the service life of the property. Because of the continuous increase of quality standards (or functional obsolescence), we note the level of initial quality, even in the absence of income decay and physical deterioration, will be below the minimum acceptable, that is the threshold demolition.

Even if the building is subjected to a regular maintenance (curve 1 of Fig. 5), in the absence of modernization, the rate of decay income not curable and the physical deterioration reduce the quality of the building over time. This circumstance determines an anticipation of the overtaking of the threshold demolition, thus reducing the useful life of the property.

The appraiser, when judging whether it is curable or not, and therefore comparing the cost of the restoring or renovation (modernization) and the increase of market value that follows, has also keep in mind that:

- extraordinary maintenance usually involves a single component that often has a strong complementarity with the rest of the building (i.e. maintenance of the structure).
- complementarity of a component should also be considered with reference to the entire complex (land and built), considering how over time varies the ratio between the land value and the building value. Whether, because of external obsolescence, the ratio between the two values is changed in favor of the built, or the demand of use for the land is changed compared to the original destination, according to which the building was designed, any extraordinary maintenance might not be convenient.

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