

# ASSESSMENT OF DAMAGE CAUSED BY THE REDUCTION OF DAYLIGHT LIGHTING DURATION OF RESIDENTIAL CONSTRUCTIONS IN THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

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ARTICLE INFO	ABSTRACT
<p><b>Keywords:</b> real estate, value, damage, compensation</p> <p><b>JEL Classification:</b> C13, D52, K11</p>	<p>This paper examines the material damage caused to the owner of the property as a result of the violation of the design rules. This phenomenon was observed by the authors participating in the period 2018-2021 in the assessment of over 500 construction projects of residential blocks on the territory of the Republic of Moldova. In about 50% was found a violation of lighting regulations. Through this study, we aimed to investigate the ways to assess the extent of the damage caused by the reduction of the level of daylight lighting in residential buildings in the specific conditions of the real estate market in the Republic of Moldova. This paper aims to: Identify the legislative and normative framework that regulates the process of ascertaining the damage caused to the owner of the residential real estate following the reduction of the level of sunshine and natural lighting; Determine the consequences of reducing the level of sunshine and natural lighting for residential buildings; Propose methods for estimating the material damage caused to the owner of the damaged real estate under the conditions of the Republic of Moldova.</p>
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## 1. Introduction

Architects consider light an essential element of design in the planning process. "Natural and artificial light illuminate architecture as a whole or in detail, creating atmospheric moods and enabling the optimal use of space. The demands for lighting planning are as diverse as the expectations and needs of users. For example, those working on computers require a glare-free and generally bright environment, while watchmakers or goldsmiths need targeted lighting. In commercial settings, lighting moods and colors are adjusted according to the product presented, whereas in cinemas or cozy cafés, soft and pleasantly warm light is required" (Skowranek, 2017).

Doctors examine light as a necessary condition for

ensuring a comfortable human life (Baggerly et al., 2015; Light Therapies ..., 2018). Insufficient light in living rooms can lead to the following problems: irritability and fear, headaches, decreased work capacity, fatigue, insomnia, stinging and red eyes; exacerbation of chronic diseases. In the case of insufficient lighting, children suffer the most; when they have to do their homework, read, play, or use gadgets in the wrong light, they may develop visual impairments.

From an urban and constructive point of view, the natural lighting of the rooms is examined depending on the lighting climate, which represents the "totality of natural lighting conditions in one or another locality (illuminance and amount of illuminance on the

horizontal plane and vertical surfaces, variously oriented on the sides of the horizon, created by scattered skylight direct sunlight, duration of solar glare and albedo of the underlying surface) over a period of more than ten years” (NCM C.04.02.2017). An important role is played by the orientation of the windows in relation to the cardinal directions, which determine the sunshine regime in the room. The state of natural light depends on the distance between buildings, the height of buildings and the proximity of green spaces.

In practice, the Republic of Moldova observes a dual attitude towards the natural lighting of residential buildings. Consumers want as much natural lighting as possible, while designers disregard the lighting requirement in the design process. Following the examination by the authors of over 500 construction projects of residential blocks located on the territory of the Republic of Moldova in the period 2018-2021, a violation of lighting regulations was found in about 50% of cases. Despite this, some of the negatively rated projects have been built.

This has led to the emergence of a new category of litigation, in which the damage estimation is dependent on the specific characteristics of the local real estate market.

In the last decade, the population of permanent residents in the municipality of Chisinau has increased by 5.5%. This has considerably boosted construction development. In the municipality of Chisinau, the number of apartments in the period 2011-2020 increased by 9.1%, and the number of single-family houses - by 8.3%, while in the city of Chisinau the number of apartments increased by 6.2%, and the number of single-family houses by 10.2%. At the same time, the built-up area of apartments located on the outskirts of the city increased by 15.4%, and the built-up area of individual houses - by 120.2%. It should also be noted that the construction of apartment buildings is developing in the city (94% of the total number of apartment buildings in the city), while detached houses are preferred outside the city, with only 34% of the total number of detached houses located in the city limits (Table 1).

**Table 1**

	Dwelling stock at end-year									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Flats in apartment buildings, thousand units										
Chisinau municipality	237.0	238.8	243.2	241.8	245.5	231.5	240.6	245.9	253.3	258.6
Chisinau city	229.6	231.5	235.8	234.5	238.2	222.6	231.5	232.2	239.1	243.9
Individual houses, thousand units										
Chisinau municipality	49.2	49.9	50.7	51.3	51.9	51.9	52.2	51.7	52.4	53.3
Chisinau city	16.4	16.7	16.9	17.1	17.2	17.4	17.5	17.7	17.9	18.1
Total area, excluding individual houses, thousand square meters										
Chisinau municipality	12957	13056	13373	13575	13844	13986	14184	14491	14968	15312
Chisinau city	12603	12703	13020	13223	13494	13556	13739	13778	14231	14546
Total area of individual houses, thousand square meters										
Chisinau municipality	4132	4281	4420	4536	4655	5785	5895	5935	6051	6188
Chisinau city	1193	1253	1301	1344	1386	2432	2502	2549	2585	2627
City share in the municipality										
Flats in apartment buildings	0.969	0.969	0.970	0.970	0.970	0.962	0.962	0.944	0.944	0.943
Individual houses	0.334	0.334	0.333	0.333	0.332	0.336	0.336	0.343	0.342	0.340

Source: own study based on statistical data (NBSRM, 2022).

Demand in the housing market has led to a considerable increase in the number of multi-story buildings (Fig. 1). If the number of 6-8 and 10-15 story apartment blocks made up 43% of the total number of apartment blocks in 2006, their share by 2020 will be 72%.

The existing demand in the real estate market, the lack of free land for construction in the city limits, and

the considerable income in the construction industry in the recent years have created a tense situation which, in combination with the political disturbances in Republic of Moldova, has led to the violation of urban and building regulations. The normative distances between buildings, the acceptable height regime for certain neighborhoods, and the demolition of buildings of historical value in order to build new

constructions are mainly violated.  
Commercial construction is also developing at a

rapid pace. On average, about 44.3 thousand m<sup>2</sup> of commercial space has been put to use annually (Fig.2).



Fig. 1. Distribution of dwellings by number of stories. Source: based on statistical data (NBSRM, 2022).

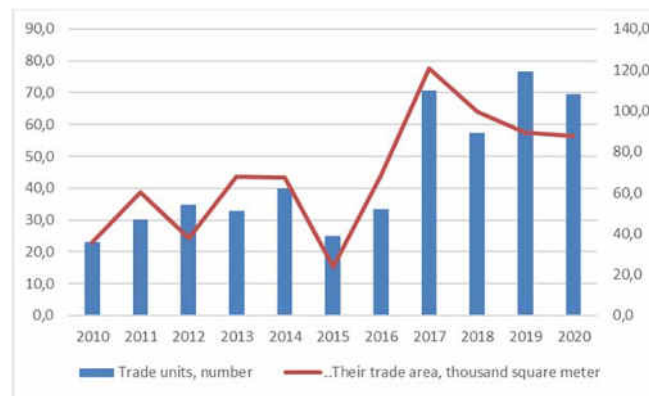


Fig. 2. Build trade units in Republic of Moldova. Source: based on statistical data (NBSRM, 2022)

As a result, conflicts have arisen in the Republic of Moldova between the owners of neighboring buildings, including violations of sunlight and daylighting rules. Many of these conflicts end up in court, where the problem of the correct assessment of the damage arises.

Through this study, we aimed to investigate the ways of assessing the extent of the damage caused by the reduction of the level of natural lighting in residential buildings in the specific conditions of the real estate market in the Republic of Moldova.

## 2. Material and methods

### 2.1. Assessment of property damage

In the legal literature, the assessment of damage is defined as the activity of establishing the nature, the particularity and the extent of the direct harmful consequences of a harmful event, which involves civil liability, as well as their monetary assessment; it is distinct and prior to determining the repair. The latter

is the activity by which, depending on the nature, particularities and value of the damage, the amount and form of compensation to which the injured person is entitled is established (Corhan, 1999).

Referring to the aspect of finding the damage caused to real estate, the literature examines in detail the methods of technical assessment, such as assessing the damage caused by natural disasters (Pampanin, 2021; Ilki, 2021) and the involvement of new technologies in the evaluation (Kusunoki, 2021).

The economic aspect of the damage caused to real estate is expressed in terms of diminution in the value (Shapiro, 2013) and, in the practice of different countries, is limited to methods of cost approach which differ only in the structure of costs and expenses considered. For example, in Italy, the damage caused by the earthquake to the real estate is estimated by determining the cost of the repair which includes: "building safety measures; demolition and removal, including transportation costs and landfill disposal; repair interventions; repair and finishing

works relevant to strengthening interventions; the testing of facilities; technical works for health and hygiene improvement; technical works to improve facilities; construction and safety costs; fees for the design and technical assistance of practitioners; and furniture moving” and Accommodation Costs (Di Ludovico, 2021). In Russia, the amount of damage suffered by individuals in relation to real estate is assessed by calculating the costs of implementing social support measures based on the minimum market cost of capital repairs (Ministry of the Russian Federation for Civil Defense, 2020).

Theoretically, specific elements include the value of the damage caused to real estate with cultural value, but in practical situations, they are also limited to assessing the costs of repairs or reconstruction within the existing funds (Forte, 2021).

In the practice of the United States of America, there are a variety of approaches to value of compensation in the event of property damage. The extent of (real) property damage by state is determined differently (White & Williams LLP, 2020; Anspach Law Office, 2022). In most states, damages are divided into permanent and temporary. In general, it is considered that permanent damage is one in which the cost of restoration of the property to its pre-damaged condition exceeds the market value of the real estate prior to damage; temporary damage is one which is not defined as permanent.

The amount of permanent damage represents:

- The difference between the property value before and after the damage. At the same time, the type of value considered differs. In Alabama, California, Idaho, Illinois, Connecticut, Delaware, Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, New Mexico, South Dakota, Vermont, Virginia, the phrase “fair market value” is used. In Arkansas, Colorado, Mississippi, Missouri, Ohio, Pennsylvania, Rhode Island, Washington the term “market value” is used. In Alaska, the District of Columbia, Florida, Hawaii, Louisiana, Montana, New Hampshire, North Carolina, Oklahoma, Oregon, South Carolina, Texas, Utah, Wyoming, the phrase “diminution in value” or “difference between the value” is applied without specifying the type of value.
- The cost of restoration or replacement, but not more than “the diminution in value” (Arizona).
- The lesser of (1) the diminution in the property's fair market value, as measured immediately

before and immediately after the damage; and (2) the cost of repairing the damage and restoring the property to its pre-trespass condition, plus the value of any lost use (California).

- The lesser of two values: (1) Cost of restoration (reasonable cost of repair), or (2) the decline in market value (reasonable market value) (New York, Tennessee). In Wisconsin, if cost of repair is awarded, the plaintiff may also recover any residual diminution in value after repairs are complete.
- The lesser of (1) the cost of repairs plus loss of use during repairs or (2) the diminution in value plus the loss of use pending replacement (North Dakota).
- The cost of repairing the damage provided that the cost of repair does not exceed the pre-damage value of the property and does not enhance the value of the property over its pre-injury value (Connecticut).
- The cost of repair or restoration and any other consequential damages, not to exceed the market value of the property immediately preceding damage to the property (Nebraska).
- The cost of repair (reasonable cost of repairing or restoring the property) and diminution in value are alternative (Georgia, Maryland, New Jersey).
- Value of the property before the damage (Indiana).
- Fair and reasonable market value (Iowa).
- Either (1) the value of the property less the salvage value or (2) the cost of replacement (Nevada).
- Fair market diminution plus consequential damages including loss of use. When residential real property is damaged, the reasonable cost of repair, even if the costs exceed fair market value before the damage. The owner of residential property may also recover related expenses stemming from the injury, annoyance, inconvenience and aggravation, and loss of use during the repair period. Where necessary to make the plaintiff whole and to the extent not duplicative, the owner of a home can also recover for any residual diminution in value after repairs are made (West Virginia).

The measure of temporary damage can be:

- The lesser of (1) the cost of repair plus rental value or (2) the diminution in value (Alabama).

- The lesser of (1) reasonable cost of repairs or (2) diminution in fair market value (Minnesota); (2) diminution in value (Oregon); (2) diminution in market value (Pennsylvania).
- The lesser of (1) the cost of repair plus any depreciation after repair or (2) fair market value diminution (Washington).
- Diminution in value or the reasonable cost of restoration, as long as the restoration cost is not disproportionate to diminution (Alaska, Delaware).
- The fair and reasonable cost of replacement or repair, but not to exceed the value of the property immediately prior to the loss or damage (Iowa).
- Reasonable costs of repair not to exceed the diminution in value caused by the damage (Kentucky, North Carolina, Oklahoma, South Dakota, Texas); not to exceed diminution in fair market value (Michigan, Missouri, New Mexico, New York); not to exceed diminution in market value (Ohio).
- Cost of restoration or repair, even if exceeding diminution in value (Arkansas, California, Georgia) (Wyoming - when damage is to a dwelling house used for the personal purpose).
- The cost of repairs or restoration unless the cost of restoring the property would exceed the value thereof in its original condition, or the depreciation in the value thereof, or the actual damages sustained, or where restoration is impracticable (Florida).
- Cost of restoration (cost of the repair) (District of Columbia, Idaho, Illinois, Indiana, Mississippi, Montana, Nevada, Rhode Island, Vermont, Wyoming).
- Reasonable repair costs with interest, potentially including the loss of use or rental value (Kansas).
- Reasonable cost of repairs plus loss of use damages (i.e.; rental value) (Massachusetts, Tennessee) not to exceed the diminished value of the property (Utah, West Virginia).

Concluding, we notice that the size of permanent damages can be expressed by one of the following types of values: Fair market value, Market value, Value, Rental value, cost of replacement, and the ways of measuring / estimating damages are different and depend on the choice of the property owner or by court decision. The size of the provisional damages is generally conditioned by the value of the cost of

restoration or cost of repair.

## **2.2. The legislative and normative framework of the Republic of Moldova**

According to Law No. 10 from 03.02.2009 on state surveillance of public health (Law..., 2009), individuals have the right to a favorable living environment (Article 27). In the case of non-compliance with the sanitary norms for the design and construction of buildings, installations and other objectives, the natural and legal persons responsible for carrying out these works are obliged to suspend or individually cease the execution and financing of the works in question, notifying the supervisory state authorities of public health (Article 32). The rooms intended for temporary or permanent housing must have safe conditions for human health and life (Article 41).

The violation of the respective provisions is ascertained following a study carried out based on the national construction regulations. As a rule, the reduction of the natural light level is conditioned by the violation of the provisions of the construction standard NCM B.01.05.2019 "Urbanism norm. Systematization and arrangement of urban and rural localities."

To ensure public health, residential buildings should be located in a well-lit and well-ventilated area to contribute to natural lighting and adequate ventilation of the premises. The distances between dwellings, residential and public buildings, as well as industrial buildings will be applied on the basis of sunlight and natural light calculations. The distance between the longitudinal sides of the collective dwelling houses is determined on the basis of the conditions of mutual invisibility of the rooms. Thus, for residential buildings with a height of 2-3 levels, the normative distance is at least 15 m, whereas for 4 levels - at least 20 m. The distance between the longitudinal and the transverse sides of the same types of constructions with windows in residential rooms should not be less than 10 m.

In areas of individual dwellings and holiday homes, the distances from the windows of the living rooms (rooms, kitchens and verandas) to the walls of houses and ancillary buildings (sheds, garages, bathrooms), located on neighboring lots, must be at least 6 m (in compliance with the requirements of mutual invisibility and shading of adjacent land). The distances from the boundaries of the lot must not be less than 3 m to the wall of the dwelling house and 1 m to household constructions.



The indicated distances can be reduced, by exception, only in the case of reconstruction or complicated urban situations, but with obligatory observance of the rules of insolation, natural lighting, fire protection requirements, as well as ensuring the mutual invisibility of the living rooms from window to window.

The heritage damage caused is to be repaired/compensated. According to the Civil Code of the Republic of Moldova (Civil Code..., 2022), art. 936. para. (1) the compensation is to cover "the actual damage suffered (including the expenses incurred and the reduction in the value of the property) and the lost profit". Article 19 specifies that the person injured in one of his rights or an interest recognized by law may request full compensation for the property and non-property damage caused in this way. The repair of the damage involves the restoration of the injured person in the situation in which he would have been if the damage had not occurred. Article 934 provides that the damage repaired by compensation also includes future damage which could reasonably have occurred.

It is for the injured party to prove the extent of the damage for which he is seeking compensation. Respectively, the compensation represents the amount of money that covers the actual damage suffered (including the expenses incurred and the reduction in the value of the property) and the lost profit of the creditor (according to article 936 CC of the RM).

### 2.3. Methods

The consequences of reducing the level of natural light, especially for residential buildings, can be summarized as follows:

- 1) Creating a destructive environment to human health. Doctors (Goncharuk, 2002) found that, in dark apartments with a low level of insolation, children are more prone to rickets. The disease is caused by D-hypo- or D-vitamin deficiency. Vitamin D is involved in calcium-phosphorus metabolism. In the case of vitamin D deficiency, the calcium and phosphorus content of the bones is reduced. As a result, children have problems with both the bones of the skull and the bones of the limbs, which become too flexible and deform under the weight of the body.
- 2) Violation of the right to intimate, family and private life respected and protected by the state through the Constitution of the Republic of

Moldova, art. 28. (The Constitution of the Republic of Moldova, 1994)

- 3) Loss / reduction of the utility of the shaded apartment / rooms, which leads to a decrease in the market value of the real estate.
- 4) Increasing the maintenance costs of the building.

These consequences have a cumulative character over time and seriously harm the owner of the property.

In order to prove the damage caused by the reduction of the duration of daylight in rooms, the appraiser must work in a team with an architect who specializes in lighting level calculations, and the following steps are necessary:

- Inspection of the immovable property and ascertainment of the shading of the rooms.
- Calculation of the Daylight Lighting Coefficient (DLC), which is the ratio of the daylight created at any given point on the plane inside the room by the light of the sky (direct or after reflections) to the simultaneous value of the horizontal outdoor illuminance created by the light of the fully open sky, expressed as a percentage.
- Comparison of the calculated daylighting coefficient with the normalized size and conclusions.
- Determining the physical and economic consequences of reducing the degree of sunlight and daylighting of the building.
- Estimating the amount of compensation covering the damage suffered by the owner of the property.

The first three stages will be carried out in accordance with building regulations. In Republic of Moldova, the functional requirements of buildings regarding lighting are indicated in the mandatory normative document NCM C.04.02.2017 Natural and artificial lighting. The rules of building physics (Blezi,2012; Vasilescu,1984; Ivanov,2007; Reference Book on Lighting, 2006;Tvarovskij,1977) and environmental hygiene requirements (Goncharuk,2002), (Friptuleac,1998) must be respected during the calculations and conclusions.

The physical consequences that are borne by the real estate as a result of reduced sunshine and daylighting duration, as well as the degree of their impact, differ from case to case. However, based on practical experience and considering the climatic conditions of the Republic of Moldova, we can group

the technical-economic consequences into immediate, annual consequences (occurring during the first year and repeated annually) and periodic, future consequences (occurring during the physical life of the building with a certain periodicity). The immediate annual consequences will include: costs of additional artificial lighting in shaded rooms; costs of additional heating of shaded rooms during the cold period of the year; additional costs for dehumidification during the warm period of the year. The consequences for the future include: reducing the frequency of current repairs to the rooms (excessive shading leads to changes in the dew point in the wall, the appearance of mold, dampness, and other damage to the finishes); reducing the periodicity of the repairs of the shaded façade.

The property damaged by excessive shading loses its usefulness, partially or fully.

The estimation of the amount of damage incurred by the owner in the conditions of the Republic of Moldova according to the modalities examined in p.2.1 encounters several impediments conditioned by the following facts:

- Constructing buildings that reduce the level of natural light in neighboring buildings is a violation of laws and regulations. The legislation stipulates the need to demolish them, but the practice of the Republic of Moldova demonstrates the impossibility of demolition, especially in the case of multi-level apartment blocks.
- The reduction of the natural lighting level does not cause momentary losses, and therefore the necessary cost of restoring the real estate to the condition before the damage in such a situation cannot be determined.
- The real estate market in the Republic of Moldova is a market with specific characteristics, the analysis of which implies a high degree of uncertainty (Albu & Albu, 2014). Demand and supply can be analyzed, but real prices cannot be analyzed. There is definite information on the number and type of real estate transactions, but not on the price of transactions; this fact is conditioned by the frequent reflection of fictitious prices in contracts (as a rule, the estimated values for taxation are indicated). The market is strongly influenced by intermediaries (which indicate on the specialized sites considerably exaggerated prices) but also by the social and economic

situation of the country. This fact does not allow the application of the direct comparison method to assess the damage, nor the application of the market approach to estimate the value of the already damaged real estate.

According to the assessment theory and methodology (The Appraisal of Real Estate, 2007; Wyatt, 2013; Anevar, 2019) the national law (Law on valuation activity, 2021; Government Decision no.958, 2003) and valuation standards (Asset valuation standards, 2022), the impact of the building located on the neighboring plot can be considered as the economic depreciation of the value (external obsolescence), which can be determined by the following methods:

- capitalization of income losses caused by external factors,
- a comparative analysis of real estate similar to the object of the evaluation that is influenced by external factors and those that are not influenced by these factors.

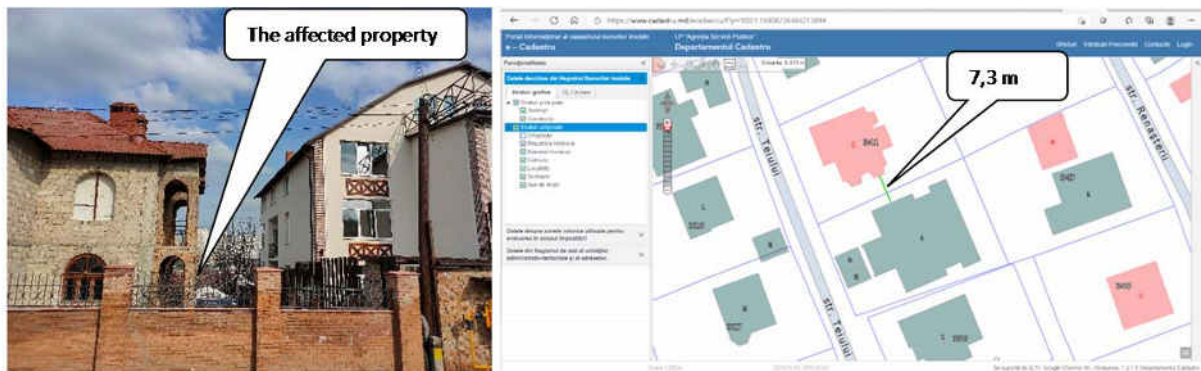
### 3. Results

#### 3.1. Case study: reducing the level of daylight lighting in the living room

In the residential neighborhood with single-family houses with 1-2 levels, a collective dwelling house with 4 levels (with 8 apartments) was built (Fig.3).

Following the inspection and calculation to determine the coefficient of Daylight Lighting (DLC) and the time of sunshine, the violation of the norms in construction was found. According to normative document NCM B.01.05:2019, the minimum distance between the buildings was to be 15 m, but de facto is merely 7.3 m (Fig.3). The minimum distance from the neighboring border is limited to 3 meters (ensuring the reciprocal invisibility of the living rooms from window to window), which de facto is 2.1 meters. It was found that the height of the neighboring building was designed too high, hence exceeding the height regulation. According to urban planning rules, the height must be up to 6 meters from the level of 0.000.

According to NCM B.05.02:2017, daylight lighting must be provided in all living rooms and kitchens, with an established DLC of 0.425%. The natural lighting in the ground floor bedroom is insufficient; the calculated DLC value is 0.292%. The living room is affected by shading.



**Fig. 3.** The negatively affected property (the distance between buildings). *Source:* original photo taken by the authors, plan according to (AGENCY, 2022)

Only two rooms are affected by shading. The level of shading does not imply the need to change their designated use.

For the examined situation, the comparative analysis of real estate similar to the object of evaluation that is influenced by external factors and those that are not influenced by these factors cannot be applied due to a lack of the necessary information on the real estate market.

The loss of income in the situation examined is connected with the additional expenses that will be borne by the owner in the future during the life of the building. The excessive shading of the room generates the following effects:

- The need for mixed lighting during periods when daylight lighting would have been sufficient.
- Excessive shading leads to the maintenance of moisture in the walls (dew point) and the occurrence of mold. Respectively, there is a need for current repairs more often than the normative sanitary conditions.
- The shaded room requires additional heating during the cold periods of the year.
- People who reside permanently in shaded rooms will be exposed over time to the development or exacerbation of respiratory diseases, neurological diseases, etc.

Only the first 3 effects were assessed in this research. The adverse impact on human health has not been assessed, as health standards are only violated in just one room in the entire house.

The calculation algorithm comprises the following

steps:

- 1) Determining the annual expenses for additional lighting for the room.
- 2) Determining the cost of current repairs, recalculated as an annual average.
- 3) Determining the annual expenses for the additional heating of the room during the heating period.
- 4) Determining the total amount of loss of income (excessive expenses) annually.
- 5) Determining the capitalization rate.
- 6) Estimating the economic depreciation by capitalizing on the annual loss of income.

The provisions of the construction regulations (CP A.09.05.2017), (VSN 58-88 (p), 1988) should be considered in the calculations. The calculation assumptions reflect the de facto situation in the respective geographical and climatic zones: the rooms are used as bedrooms; the bright average period of the day is considered from 7:00 to 18:00; the actual period of using the room is considered as being 6 hours/day: between 7:00 – 10:00 and 15:00 – 18:00; each room is lit with 2 bulbs, 75W each (according to the current situation, found during the inspection of the property); the heating period is assumed as five months; the additional heating time for the room is considered to be 4 hours per day with a 2-kW electric heater; the cost of the current repair is estimated based on the analysis of market prices for repair work in analog format to the existing one. The Civil Code of the Republic of Moldova stipulates, in the art. 874, art. 944 and art. 1743, that the capitalization rate is equal to the base rate of the National Bank of Moldova.



**Table 2**

Assessment of damage caused by the reduction of daylight lighting duration	
Indicator	Value
<i>The annual expenses for additional lighting for the room</i>	1104 MLD/year
of additional artificial lighting	2190 h/year
electricity consumption	657 kWh/year
the price of electricity	1,68 MLD/kWh
<i>The cost of current repairs, recalculated as an annual average</i>	8 150 MLD/year
the normative exploitation duration of the construction	100 years
chronological age of construction	17 years
frequency of current repairs under normal conditions	3-5 years
violation of regulations	2-3 years
considered in the calculations	3 years
the cost of current repair	24450 MLD
<i>The annual expenses for the additional heating of the room during the heating period</i>	4032 MLD/year
additional warming time	4 h/day
heating period	5 months/year
electricity consumption	2400 kWh/year
<i>The total amount of lost income (excessive expenses)</i>	13 286 MLD/year
The total amount of lost income (overspending) over the remaining life of the building	1 102 738 MLD
The capitalization rate	2,65 %
<i>Damage</i>	501 358 MLD or 24 000 euro
Market value without taking into account the damage	157 000 euro
<i>Reduction in market value as a result of day lighting and sunshine regulations violations</i>	15,3%

Source: own study.

The valuation was carried out by the author who is a certified valuer in Republic of Moldova. Following the steps in the above-mentioned algorithm, it was found that the property damage amounted to 24 thousand Euros (Tab.2).

The market value of the residential house was estimated according to the legislation of the Republic of Moldova and the recommendations of the IVS under the assumption of no violations. The comparative analysis method, the discounting cash-flow method and the reproduction cost method followed by reconciliation of results were applied. Thus, it was found that the damage caused by the reduction in day lighting and sunlight to the valued property requires a 15% reduction in the market value.

The case study demonstrates a considerable impact of reduced lighting and sunlight on the market value of the property and the possibility of estimating the damage using an approach similar to economic depreciation of the value of the property.

### 3.2. Case study: full shading of living rooms

The examined real estate is a "ground floor apartment" as part of a residential building built in 1918, which, in the 50s of the twentieth century, was

divided into separate apartments. A 4-storey building, used as a hotel, was recently built on the neighboring plot (Fig. 4).

Following the inspection and determination of the daylight lighting coefficient and the sunshine time, it was found that:

- The construction of the neighboring building completely overshadows the examined apartment.
- The initial sunshine of the living room was 1 hour 20 minutes. After the extension of the construction of the neighboring building, there was total shading, i.e., 00 hours 00 minutes (Fig.5).
- Following the calculation of the daylight lighting coefficient, the volume of natural light decreases below the sanitary norm of DLC = 0.18% (Fig.6).
- The extension of the neighboring building to the examined residential building was designed in violation of the normative provisions on constraints and sanitary norms in the Republic of Moldova.



Fig. 4. Full room shading. Source: original photo taken by the authors.

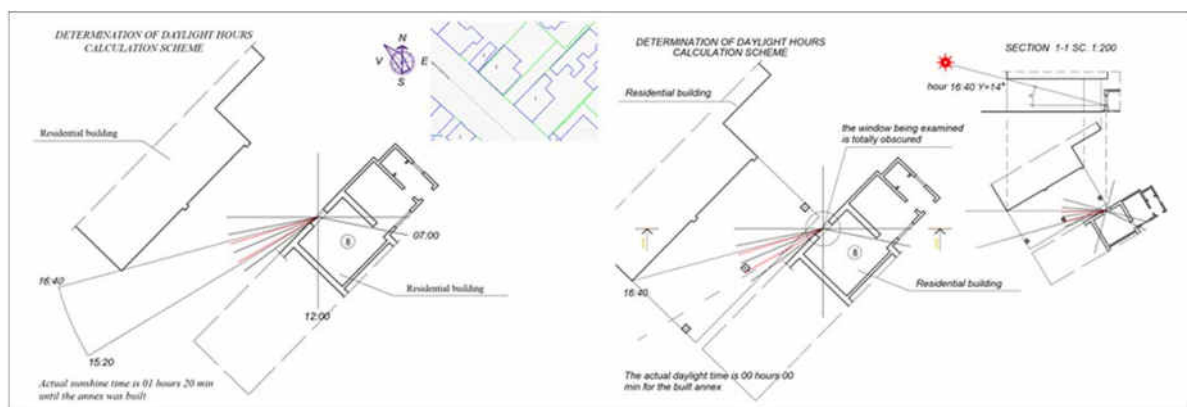


Fig. 5. Sunshine of the living room before and after the construction of the neighboring building. Source: own study.

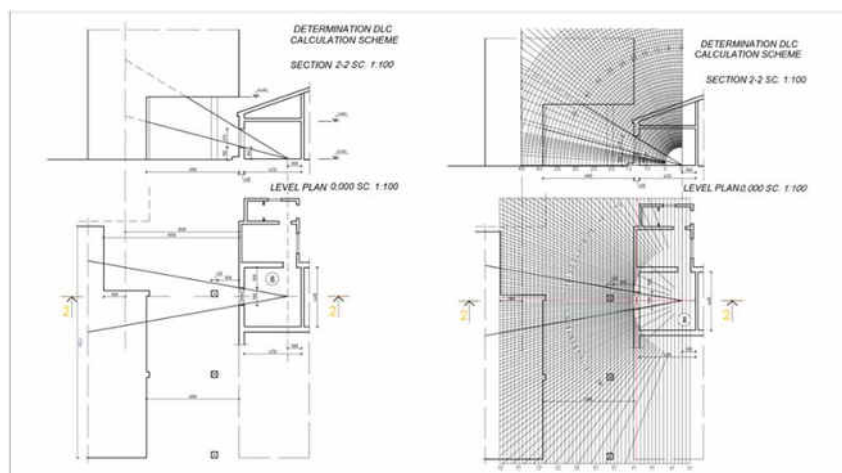


Fig. 6. Scheme for calculating the daylight lighting coefficient (DLC). Source: own study.

According to the provisions of the Regulation on the conduct of technical and sanitary research of dwellings for their recognition as unusable for living, as well as the use, redevelopment, or demolition (Government Decision 175 of 23.02.2016), inadequate daylight lighting, shading of windows, and lack of lighting in accordance with regulations are defects, due to which the dwellings do not meet the sanitary and technical requirements for living.

The violations were found to lead to a reduction in the market value of the property. This decrease is conditioned by the fact that the non-compliance of the isolated rooms (of the apartment) with the sanitary and technical requirements for living entails the change of the use of the room from living space to auxiliary space (non-living: e.g. storage, building service, etc.).

Therefore, the reduction in the value of the

property (damage D) is equal to the difference between the market value (MV) of the respective detached rooms, examined as an apartment, and the market value of the rooms examined as ancillary rooms (eq.1).

$$D = MV (\text{current use}) - MV (\text{highest and best use}) \quad (1)$$

Following the analysis of the „highest and best use“ of the affected “ground floor apartment”, it was found that it can be used as a warehouse for non-food goods.

As a result of the evaluation, it was found that the amount of property damage is 12 thousand Euros, and the value of the examined "ground floor apartment" decreased by 47%.

Following the application of the calculation algorithm mentioned in the first case study, the damage exceeds the market value of the "ground floor flat" under normal conditions.

#### 4. Discussion

The amount of compensation for property damage depends on each specific situation and can be estimated by updating the excessive expenses during the remaining period of the economic life of the construction. In cases of serious infringements (as in the second case study), the loss of value of the property can be determined by comparing the market value for existing use with the market value for the most likely use considering the shading of the rooms.

In practice, there may also be intermediate

situations where the property loses only part of its usefulness, i.e. the assessor may apply both valuation methods. Valuation theory (as well as Moldovan law) indicates the application of the process of reconciling the results obtained by different methods to recommend the final value. However, in the case of estimating material damage, we consider the application of this procedure incorrect and unjustified. Recommendation for the following reasoning for the conclusions: the market value of the real estate is the highest amount that can be negotiated for the most probable use; the damage found in the analysis decreases the market value of the real estate; the highest amount offered for the damaged real estate will correspond to the lowest deduction; therefore, the value of the material damage is the minimum amount determined by the appraiser after the analysis.

The present research is limited only to the estimation of the material damage, i.e. the real damage conditioned by the reduction in the value of the immovable property. The authors do not examine the extent of lost profit nor the non-pecuniary (moral) damage caused to the owner of the property.

#### 5. Conclusions

Concluding, we propose to select the method of estimating the damage caused by reducing the level of insolation and natural lighting depending on the consequences of shading (Tab. 3).

**Table 3**

The assessment method of the amount of damage depending on the shading mode		
The shading mode	Consequence	Damage size
Shading of a room (s) <sup>1</sup> in the building with the possibility of keeping the destination.	Increasing building maintenance costs.	The updated value of the additional costs over the remaining economic life of the building.
Shading of a room (s) in the building with the impossibility of keeping the destination.	Reduction of the residential area of the real estate. Possibly increasing certain categories of maintenance costs.	The minimum size of (1) The reduction in market value considering the change in the utilitarian structure of the areas and (2) the updated value of the additional costs.
Shading of the real estate (apartment) with the impossibility of keeping the destination.	Changing the destination of the property.	The positive difference between the market value of the residential property and the market value of the property with legal and physically possible alternative use (requested on the market).

Source: own study.

<sup>1</sup> Any room (s) except ancillary spaces and rooms without windows.

Violation of the rules of sunshine and daylight harms the person's heritage and non-heritage rights. The heritage damage includes the real damage suffered, in particular the reduction in the value of the real estate and, possibly, the lost profit. The non-heritage damage (non-pecuniary damage) is conditioned by the mental suffering generated by the violation of the right to intimate, family, and private life, as well as the diminution of the quality of life by the formation, over time, of an environment detrimental to human health.

The modality of estimating the material damage recommended by the authors will allow a correct and justified assessment in condition of the Republic of Moldova of the amount of compensation requested by the owner of the affected property.

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### Conflict of interest

The authors declare no conflicts of interest regarding the publication of this paper.

### References

- Advances in Assessment and Modeling of Earthquake Loss* (Ed.). (2021). Sinan Akkar, A. I. Springer Tracts in Civil Engineering., <https://doi.org/10.1007/978-3-030-68813-4>
- Albu, S., & Albu, I. (2014). Piațaimobiliară. (Real estate market). Tehnica-UTM.
- Anspach Law Office. (2022). Measure of Damages for Real Property. Chicago. <https://www.anspachlawoffice.com/real-property-damages-article/#:~:text=As%20a%20general%20rule%2C%20the%20measure%20of%20damages,is%20the%20true%20and%20better%20rule%20to%20apply.?msclkid=4e5800a7b24c11ecbf3f2b6593b3cb34>
- Asociația Națională a Evaluatorilor Autorizați din România. (2019). Evaluareaproprietăți imobiliare. (Real estate valuation). ANEVAR. București.
- Baggerly, C. A., Cuomo, R. E., French, C. B., Garland, C. F., Gorham, E. D., Grant, W. B., Heaney, R. P., Holick, M. F., Hollis, B. W., McDonnell, S. L., Pittaway, M., Seaton, P., Wagner, C. L., & Wunsch, A. (2015). Sunlight and Vitamin D: Necessary for Public Health. *Journal of the American College of Nutrition*, 34, 359–365. <https://doi.org/10.1080/07315724.2015.1039866> PMID:26098394
- Codul Civil al R.Moldova. (2022). (Civil Code of the Republic of Moldova.) [https://www.legis.md/cautare/getResults?doc\\_id=129081&lang=ro#](https://www.legis.md/cautare/getResults?doc_id=129081&lang=ro#)
- Constituția R.Moldova. (1994). (The Constitution of the Republic of Moldova.) [https://www.legis.md/cautare/getResults?doc\\_id=128016&lang=ro#](https://www.legis.md/cautare/getResults?doc_id=128016&lang=ro#)
- Corhan, A. (1999). Reparareaprejudiciului prin echivalent bănesc. (Compensation for damage by monetary equivalent). București: Lumina Lex.
- Di Ludovico, M., De Martino, G., Prota, A., Manfredi, G. and M. Dolce (2021). Damage Assessment in Italy, and Experiences After Recent Earthquakes on Reparability and Repair Costs, pp. 65-84 in: *Advances in Assessment and Modeling of Earthquake Loss*, ed. Akkar S. Springer Tracts in Civil Engineering. doi:10.1007/978-3-030-68813-4\_4.
- Documente normative în construcții. CP A.09.05.2017 Normeșireguli de exploatare tehnică a fondului locativ. (Standard documents in construction. CP A.09.05.2017 Norms and rules for the technical operation of housing stock.) <http://www.ednc.gov.md/>
- Documente normative în construcții. NCM B.01.05.2019 Urbanism. Sistemizarea și amenajarea localităților urbane și rurale. (Standard documents in construction. NCM B.01.05. (2019). Urbanism norm. Systematization and arrangement of urban and rural localities.) <http://www.ednc.gov.md/>
- Documente normative în construcții. NCM C.04.02.2017 Iluminatul natural și artificial. (Standard documents in construction. NCM C.04.02.2017 Natural and artificial lighting.) <http://www.ednc.gov.md/>
- Documente normative în construcții. VSN 58-88 (p). (1988). Regulations on the organisation and implementation of reconstruction, repair and maintenance of residential buildings, communal and socio-cultural facilities.
- Forte, F., Del Giudice, V., De Paola, P., & Del Giudice, F. (2021). Cultural Heritage and Seismic Disasters: Assessment Methods and Damage Types, pp 163-176, in: *Appraisal and Valuation. Contemporary Issues and New Frontiers*, ed. Morano P. et al. *Green Energy and Technology*. [https://doi.org/10.1007/978-3-030-49579-4\\_12](https://doi.org/10.1007/978-3-030-49579-4_12)
- Friptuleac, G., Alexa, L., & Babalau, V. (1998). *Igienamediuului*. (Environmental hygiene). Știința.
- Hotărârea Guvernului 175 din 23.02.2016. Cu privire la aprobarea Regulamentului privind modul de efectuare a cercetărilor tehnico-sanitare a locuințelor pentru recunoașterea lor ca fiind inutile pentru locuit, precum și modul de folosire, reamenajare sau demolare. (Government Decision 175 of 23.02.2016. On the approval of the Regulation on the conduct of technical and sanitary research of dwellings for their recognition as unusable for living, as well as the use, redevelopment, or demolition) [https://www.legis.md/cautare/getResults?doc\\_id=91186&lang=ro](https://www.legis.md/cautare/getResults?doc_id=91186&lang=ro)
- Hotărârea Guvernului nr.958 din 04.08.2003 despre aprobarea Regulamentului provizoriu privind evaluarea bunurilor imobiliare. (Government Decision no.958 of 04.08.2003 on the approval of the Provisional Regulation on the Valuation of Real Estate) [https://www.legis.md/cautare/getResults?doc\\_id=28063&lang=ro](https://www.legis.md/cautare/getResults?doc_id=28063&lang=ro)
- Ilki, A., Halici, O.F., Comert, M., Demir, C. (2021). The Modified Post-earthquake Damage Assessment Methodology for TCIP (TCIP-DAM-2020), pp.85-107 in: *Advances in Assessment and Modeling of Earthquake Loss*, ed. Akkar S., et al. Springer Tracts in Civil Engineering. doi:10.1007/978-3-030-68813-4\_5.
- Ivanov, V. I. (2007). Determinarea iluminatului natural în încăperi de locuit. (Determination of natural lighting in habitable rooms) Chisinau: UTM.
- Kusunoki, K. (2021). Damage Assessment in Japan and Potential Use of New Technologies in Damage Assessment, pp. 27-46 in: *Advances in Assessment and Modeling of Earthquake Loss*, ed. Akkar S., et al. Springer Tracts in Civil Engineering. doi: [https://doi.org/10.1007/978-3-030-68813-4\\_2](https://doi.org/10.1007/978-3-030-68813-4_2).
- Legea Nr. 989 din 18.04.2002 cu privire la activitatea de evaluare.



- (LAW No. 989 of 18.04.2002 on valuation activity)[https://www.legis.md/cautare/getResults?doc\\_id=128398&lang=ro#](https://www.legis.md/cautare/getResults?doc_id=128398&lang=ro#)
- Legea Nr.10 din 03.02.2009 privind supravegherea de stat a sănătății publice. (LAW No. 10 of 03.02.2009 on state surveillance of public health)[https://www.legis.md/cautare/getResults?doc\\_id=125959&lang=ro#](https://www.legis.md/cautare/getResults?doc_id=125959&lang=ro#)
- Light Therapies. A Complete Guide for the Healing Power of the Light. ed. Martel, A. (2018). Healing Arts Press, Rochester, Vermont. <https://www.goodreads.com/book/show/35721522-light-therapies>
- NBSRM (2022). National Bureau of Statistics of the Republic of Moldova. Statistical databank. Chisinau. <https://statistica.gov.md/pageview.php?l=ro&idc=407&nod=1&>
- Pampanin, S. (2021). Simplified Analytical/Mechanical Procedure for Post-earthquake Safety Evaluation and Loss Assessment of Buildings. In *Advances in Assessment and Modeling of Earthquake Loss*. Springer Tracts in Civil Engineering. doi:10.1007/978-3-030-68813-4\_1.
- Public Services Agency (2022). Real estate cadastre information portal. <https://www.cadastru.md/ecadastru/f?p=100:1:2131418583851079#>
- Shapiro, E., Mackmin, D., Sams, G. (2013). Modern methods of valuation (11th ed.). London and New York: Routledge.
- Skowranek, R. (2017). Basics lighting design. Birkhäuser.
- Standardele de evaluare a bunurilor. (2022). (Property valuation standards.) Bucuresti: ANEVAR.
- Timothy, N. (2022). Damages For Injury To Real Property: The Lesser Of Rule. Los Angeles. <https://constructiondefect.com/damages-for-injury-to-real/?msclkid=4e594288b24c11eca4106223c156160b>
- Vasilescu, G. M. (1984). Iluminarea naturală și artificială la clădirile civile și de producție. (Natural and artificial lighting in civil and production buildings.) Bucurști: Editura Tehnica.
- White and Williams LLP. (2020). Nationwide Measures of Damages to Property. [https://www.whiteandwilliams.com/assets/htmldocuments/Subro%20Charts%20Updated%205\\_10\\_16/DAMAGES%20-%20MEASURE%20OF%20DAMAGES%20TO%20PROPERTY%20-%20REV.%2011-20-19.PDF](https://www.whiteandwilliams.com/assets/htmldocuments/Subro%20Charts%20Updated%205_10_16/DAMAGES%20-%20MEASURE%20OF%20DAMAGES%20TO%20PROPERTY%20-%20REV.%2011-20-19.PDF)
- Wyatt, P. (2013). Property valuation (2d ed.). WILEY-BLACKWELL.
- Блэзи, В. (2012). Справочник проектировщика. Строительная физика. Москва: Техносфера. (Blaisy, W. (2012). The designer's handbook. Construction physics. Moscow: Technosphere.)
- Гончарук, Е. (2002). Комунальная гигиена. Киев: Вищашк. (Goncharuk, E. (2002). Communal Hygiene. Kiev: Vyshchashk.)
- Крот, А. Д., Дмитракович, Н.М. (2019). Методика оценки экономического ущерба от пожара в лесном фонде: современный подход, сс.3-12 В: *Вестник полесского государственного университета. Серия общественных и гуманитарных наук*(1). <https://cyberleninka.ru/article/n/metodika-otsenki-ekonomicheskogo-uscherba-ot-pozhara-v-lesnom-fonde-sovremennyy-podhod>(Krot, A. D., Dmitrakovich N.M.(2019) Methodology for assessing economic damage from forest fires: a modern approach, pp. 3-12 in: *Vestnik Polesskogogosudarstvennougouniversiteta. Series of Social Sciences and Humanities*(1))
- Оценке недвижимости (изд. 11). ред. Артеменков, И. (2007). М: ОО "Российское общество оценщиков". (The appraisal of real estate (ed. 11). transl. from English, ed. by Artemenkov, I. (2007). Public Association "Russian Society of Appraisers". Moscow)
- Приказ № 631 от 01.09.2020 Министерства Российской Федерации по делам гражданской обороны Об утверждении Методики оценки ущерба от чрезвычайных ситуаций. Электронный фонд правовых и нормативно-технических документов: <https://docs.cntd.ru/document/566006381>(Order No. 631 of 01.09.2020 of the Ministry of the Russian Federation for Civil Defense On approval of the Methodology for assessing damage from emergencies. Electronic collection of legal and normative-technical documents.)
- Справочная книга по светотехнике (изд. 3). ред. Айзенберг, Ю. (2006). Москва: Знак. (Reference book on lighting engineering (ed. 3). ed. Eisenberg, Y. (2006). Moscow: Znak.)
- Тваровский, М. (1977). Солнце в архитектуре. Москва: Стройиздат. (Tvarovsky, M. (1977). The Sun in Architecture. Moscow: Stroyizdat.)