



VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF CIVIL ENGINEERING
DEPARTMENT OF CONSTRUCTION ECONOMICS AND PROPERTY MANAGEMENT

Fátima Soler Curiel

**HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT
SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC
HYGIENE, PESTS AND REFUSE AND ELECTRICAL
HAZARD**

Master's degree Thesis

Real Estate Management study programme, state code 621N20013

Real Estate Management specialization

Management studies

Vilnius, 2014



UNIVERSIDAD POLITÉCNICA DE VALENCIA
ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA DE EDIFICACIÓN

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HYGIENE, PESTS AND REFUSE AND ELECTRICAL
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Master en Gestión de Edificación

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Vilnius, 2014

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
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OBJECTIVES FOR MASTER THESIS

.....No.
Vilnius

For student Fátima Soler Curiel
(Name, Surname)

Master Thesis title: HEALTHY HOUSE AND VIRTUAL INTELLIGENT SYSTEM.
APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS
AND REFUSE AND ELECTRICAL HAZARD.....

Approved on , 201... by Dean's decree No.
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The Final work has to be completed by , 201.....
(Day, Month) (Year)

THE OBJECTIVES:

Study Housing Health and Safety Decision Support System.....
Analyze the healthy problems we are exposed to, relating to lighting, noise, domestic hygiene,
pests and refuse, and electrical hazard.....
Propose recommendations to follow to eliminate or decrease them.....
Create an interactive tool: Virtual House Intelligent System.....
.....
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VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF CIVIL ENGINEERING
DEPARTMENT OF CONSTRUCTION ECONOMICS AND PROPERTY MANAGEMENT

**REVIEW
ABOUT MASTER THESIS**

.....No.
Vilnius

StudentFátima Soler Curiel.....
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Master Thesis title: ... HEALTHY HOUSE AND VIRTUAL INTELLIGENT SYSTEM. APPLIED
TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL
HAZARD.....

REVIEW

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HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

**Master Thesis of Real Estate and Property VGTU (Lithuania): Fátima Soler Curiel
Supervisor VGTU (Lithuania): Arturas Kaklauskas
Supervisor UPV (Spain): M^a Carmen Llinares
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INDEX

INDEX	Pag. 1
CHAPTER I: Introduction	Pag. 3
1.1. Previous considerations	Pag. 3
1.1.1. Evolution of interest of the topic “Healthy House” and keywords in the scientific literature	Pag. 4
1.2. Objectives	Pag. 6
1.3. Research methodology	Pag. 6
CHAPTER II: Housing Health and Safety Model	Pag. 8
2.1. Housing Health and Safety Rating System	Pag. 8
2.2. The model	Pag. 9
2.3. 29 criteria system	Pag. 10
2.3.1. Lighting	Pag. 12
2.3.1.1. Description of the hazard	Pag. 12
2.3.1.2. Health effects	Pag. 12
2.3.1.3. Causes	Pag. 13
2.3.1.4. Relevant matters affecting likelihood and harm outcome	Pag. 13
2.3.1.5. Hazard assessment	Pag. 14
2.3.2. Noise	Pag. 14
2.3.2.1. Description of the hazard	Pag. 14
2.3.2.2. Health effects	Pag. 14
2.3.2.3. Causes	Pag. 15
2.3.2.4. Relevant matters affecting likelihood and harm outcome	Pag. 16
2.3.2.5. Hazard assessment	Pag. 16
2.4. Development of recommendations	Pag. 17
2.4.1. Lighting recommendations	Pag. 17
2.4.2. Noise recommendations	Pag. 19
2.5. Multiple criteria analysis	Pag. 20
2.5.1. Determination of the weight of the criteria (MEDICI)	Pag. 20
2.5.2. Method of multiple criteria complex proportional assessment (COPRAS)	Pag. 23
2.5.3. A method of defining the utility and market value of a property (DUMA)	Pag. 27
CHAPTER III: Decision Support System	Pag. 32

**HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO
LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL
HAZARD**

3.1. A housing health and safety multiple criteria decision support system	Pag. 33
3.2. Database	Pag. 33
3.2.1. Database problems analysis	Pag. 37
3.2.1.1. Domestic hygiene, pests and refuse	Pag. 37
3.2.1.2. Electrical hazard	Pag. 41
3.2.2. Database recommendations	Pag. 43
3.2.2.1. Domestic hygiene, pests and refuse recommendations	Pag. 43
3.2.2.2. Electrical hazard recommendations	Pag. 46
3.3. Model-Base	Pag. 49
3.4. Calculators	Pag. 53
3.4.1. Lighting calculator	Pag. 53
3.4.2. Noise calculator	Pag. 55
3.4.3. Electrical calculator	Pag. 57
CHAPTER IV: Case study	Pag. 59
4.1. Creation of a virtual house	Pag. 59
4.2. Virtual House Intelligent System	Pag. 61
CHAPTER V: Instruction for users manual	Pag. 65
5.1. Operation manual for Virtual House Intelligent System	Pag. 65
5.2. Operation manual for Health and Safe Recommendation System	Pag. 65
5.3. Operation manual for National Health Recommendation Certification Model Advisory System	Pag. 68
5.3.1. Adding content	Pag. 70
CHAPTER VI: Conclusions	Pag. 76
APPENDIX I	Pag. 78
BIBLIOGRAPHY	Pag. 99
References	Pag. 99
Figures	Pag. 102
Tables	Pag. 104
Graphics	Pag. 104

CHAPTER I: Introduction

1.1. PREVIOUS CONSIDERATIONS

Nowadays, the people spend long time indoor, at home, at work, in the university or school, gain relevance the indoor environment. We find an interesting fact [4] which remarks *“the average North American spends 90 percent or more of life indoors”*. It becomes obvious the importance of this datum.

According to others researches [4], one of the top four environmental health risks, identify by the US Environmental Protection Agency (EPA) and the Scientific Advisory Board authorized by Congress to consult with the EPA on technical matters, is the indoor air pollution. It has been estimated to cause thousands of cancer deaths and hundreds of thousands of respiratory health problems each year.

In these times of technological advancement, it has sense that we would use our knowledge to create appropriate indoor environments, in which our welfare and health would enhance.

Many housing deficiencies impact on health and safety. Playing a decisive role in the health status of its occupants the quality of housing. The most vulnerable groups in this case are children and seniors, being exposed to a large of safety and health hazard at home, which could produce serious diseases and injuries, and sometimes it could be fatal. For example, a lack of natural lightning, an inappropriate artificial lightning, too much noise in the inside of a dwelling, small electrical shocks or supply failure and pests are some of the causes for the health problems we suffer nowadays, like severe headache, migraine, gastrointestinal problems, stress, anxiety, poisoning, etc.

Sometimes, these problems are the result of a bad structural design, either because of a structural error or because the user is not kept in mind, and one only tries to meet the minimum amount required by the various legislations. In this age, as it is said [7] *“The housing design and construction industry has made great progress in recent years through the development of new innovative techniques, materials technologies, and products”*.

But unfortunately, older homes are more prone to be affected by some kinds of problems, like moisture intrusion due to poor maintenance, design deficiencies or deterioration. Only now, disease and injury outcomes, which have been contributed by these conditions, are beginning to be recognized. For example, another interesting fact found marks [27] *“asthma rates among children have more than doubled in the past 10 years and a new type of fatal lung injury caused by exposure to toxic mold has appeared”*

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

And what else could be the origin of these deficiencies? Maybe, they may also have their origin in a poor maintenance by the user. They might not be aware of the hazard they are exposed to in their dwellings, either because of lack of information or because of an erroneous information.

The concept of the idea "Healthy House" is a way to respond the concern about the link between health issues and housing. In view of we spend so much time at home, we need a safe environment to eat, play and raise our families. "Healthy House" is to create a home environment without allergens, pests, contaminants and injury hazards that can produce us health problems.

1.1.1. EVOLUTION OF INTEREST OF THE TOPIC “HEALTHY HOUSE” AND KEYWORDS IN THE SCIENTIFIC LITERATURE

Once we have talked about “Healthy House”, in order to know the relevance of the main topic, it was done an exhaustive research and an analysis about it and the main keywords around it.

To achieve real and specifics results, it was made a search with some limitations. One of them was journal-peer reviewed to narrow the search itself; the other was the age of range from 1990 to nowadays.

The search to study the evolution of interest about this topic has produced the following results (*Table 1.1.*):

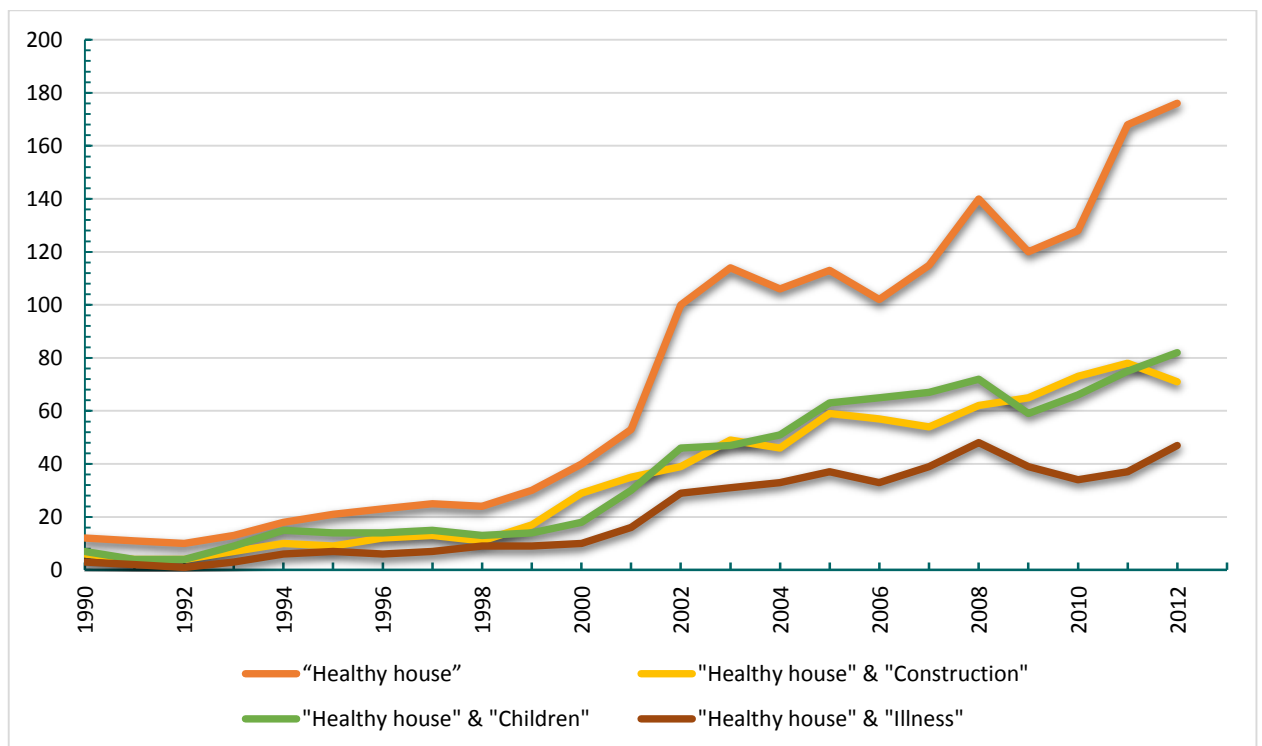
“Healthy house”		"Healthy house" & "Construction"		"Healthy house" & "Children"		"Healthy house" & "Illness"	
Date	Results	Date	Results	Date	Results	Date	Results
1990	12	1990	6	1990	7	1990	3
1991	11	1991	4	1991	4	1991	2
1992	10	1992	4	1992	4	1992	1
1993	13	1993	7	1993	9	1993	3
1994	18	1994	10	1994	15	1994	6
1995	21	1995	9	1995	14	1995	7
1996	23	1996	12	1996	14	1996	6
1997	25	1997	13	1997	15	1997	7
1998	24	1998	11	1998	13	1998	9
1999	30	1999	17	1999	14	1999	9
2000	40	2000	29	2000	18	2000	10
2001	53	2001	35	2001	30	2001	16
2002	100	2002	39	2002	46	2002	29
2003	114	2003	49	2003	47	2003	31
2004	106	2004	46	2004	51	2004	33

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

2005	113	2005	59	2005	63	2005	37
2006	102	2006	57	2006	65	2006	33
2007	115	2007	54	2007	67	2007	39
2008	140	2008	62	2008	72	2008	48
2009	120	2009	65	2009	59	2009	39
2010	128	2010	73	2010	66	2010	34
2011	168	2011	78	2011	75	2011	37
2012	176	2012	71	2012	82	2012	47

Table 1.1. Search results

After these results, it has been made a graphic (*Graphic 1.1.*), in where we can see more simply.



Graphic 1.1. Evolution of the interest of the keywords

As can be observed in the graphic, the interest of the topic “Healthy House” has been increased in the last years, developing an upscale slope, which means that this topic is currently being a topic of interest.

Moreover, relating to keywords, can be observed similar results in “construction” and “children”, two of the most important aspects that we have been previously presented.

1.2. OBJECTIVES

The main objective of this work is to achieve a healthy environment, preventing future diseases which could reach the house, because of damages on them, and users well informed about all this possible and future problems.

This objective is developed in the following specific objectives:

- To study the healthy problems that we are exposed to, relating to problems of lighting, noise, domestic hygiene, pests and refuse, and electrical hazards.
- To propose some recommendations to follow to decrease or eliminate the healthy problems.
- To create a virtual house intelligent system which includes all the problems that have been analyzed and the recommendations. An easy virtual tool for the occupants, where they can see, with pictures as example, how the problems could appear in their dwelling and directly the recommendations that are suggested.

1.3. RESEARCH METHODOLOGY

In order to achieve the main objective of this work, a work plan structured in the following steps are proposed:

Stage I. Firstly, to study the evolution of the interest of the topic “Healthy House” and keywords in the scientific literature.

Stage II. After the results, to make a literature review about “Healthy House”.

It is necessary to make an analysis about Housing Health and Safety Model (HHSM). For this analysis some articles about the topic need to be revised [29, 32, 35].

First, we need to analyze Housing Health and Safety Rating System, which talks about the 29 hazard that could appear in dwellings, and how they are classify in four groups according to the nature of the hazards.

After, it is necessary to analyze the model, which is composed of six stage. According with these six stage, the problems which are the purpose of this work (lighting, noise, domestic hygiene, pests and refuse, and electrical hazard) have to be investigated. We need to describe the hazards, their health effects, what might be the causes and another relevant information about them.

It will also carry out a search of recommendations, in order to solve or prevent the problems.

And the last aspect to study in this stage is the multiple criteria analysis. It is necessary to study the three most important methods for performing multiple criteria analysis of the research

object: MEthod of complex Determination of the weIght of the CrIteria taking into account their quantitative and qualitative characteristics (MEDICI); Method of multiple criteria complex proportional evaluation of the projects (COPRAS); method of Defining the Utility degree and MArket value of a project (DUMA).

Stage III. As the objective is to create an interactive tool with the problems and the recommendations to help the users, it is necessary to analyze decision support system. This system consist of a database, database management system, model-base, model-base management system and user interface.

The database includes the information about the hazards in dwellings, as tables assessing health and safety recommendations. Also it is include some calculators, which need to be investigate, to evaluate the hazard.

The model-base includes a model for determining the initial significances of the criteria, a model for the criteria significance establishment, a model for multivariant design of a housing health and safety, a model for multiple criteria analysis and setting the priorities, a model for determination of project utility degree and a model for providing recommendations.

Stage IV. In this point, it will be develop the interactive tool “Virtual House Intelligent System”.

In first place, we need to virtualize a scenery, chosen a dwelling to its study. Then, take pictures of the different rooms, which built it, in order to create a “Virtual Tour” helped by technical programs like “Kolor Autopano” and “Kolor Panotour”.

It will be identify the problems subject of enquiry (lighting, noise, and domestic hygiene, pests and refuse and electrical hazard), existing now or in future, and add them in the created virtual house.

And finally, some external links to the recommendations database and calculator will be integrate too in the virtual house.

Stage V. The last stage will be to give the instruction for users manual. How to move in the virtual tour, how works the recommendations databases, and to conclude this stage, how will be possible to add information in these databases.

CHAPTER II: Housing Health and Safety Model

2.1. HOUSING HEALTH AND SAFETY RATING SYSTEM

Certain groups of patients included in American Lung Association's study are those such as asthmatics, atopic patients, patients with emphysema and bronchitis, heart and stroke patients, people with diabetes, pregnant women, and the elderly and children who are especially sensitive to the health effects of outdoor air toxicants [2]. It is estimated that about 20% of the USA's population suffers from asthma, emphysema, bronchitis, diabetes or cardiovascular diseases and are thus especially susceptible to outdoor air pollution [2]. Outdoor air quality plays an important role in maintaining good human health. Air pollution causes large increases in medical expenses, morbidity and is estimated to cause about 800,000 annual premature deaths worldwide [9]. Much research [3,6,18], digital maps and standards [15, 25, 36] on the health effects (respiratory effects, cardiovascular effects, cancer, reproductive and developmental effects, neurological effects, mortality, infection and other health effects) of outdoor air pollution, a premise's microclimate, and dwelling valuation, has been published in the last decade. The above-mentioned and other problems are related to a built environment's air pollution, the premise's microclimate, health effects, and real estate market value, etc. However, a Housing Health and Safety Decision Support System with Augmented Reality (HUSSAR) can analyse the above factors in an integrated way.

The Housing Health and Safety Rating System (HHSRS or the Rating System) is the UK Government's new approach to the evaluation of the potential risks to health and safety from any deficiencies identified in dwellings. There are 29 hazards in dwellings. These are arranged in four main groups reflecting the basic health requirements. The four groups are sub-divided according to the nature of the hazards [32] (*Figure 2.1.*):

- Physiological Requirements, including – Hygrothermal conditions and Pollutants (non-microbial).
- Psychological Requirements, including – Space, Security, Light, and Noise.
- Protection against Infection, including – Hygiene, Sanitation, and Water supply.
- Protection against Accidents, including – Falls, Electric shock, Burns and Scalds, and Building related Collisions.

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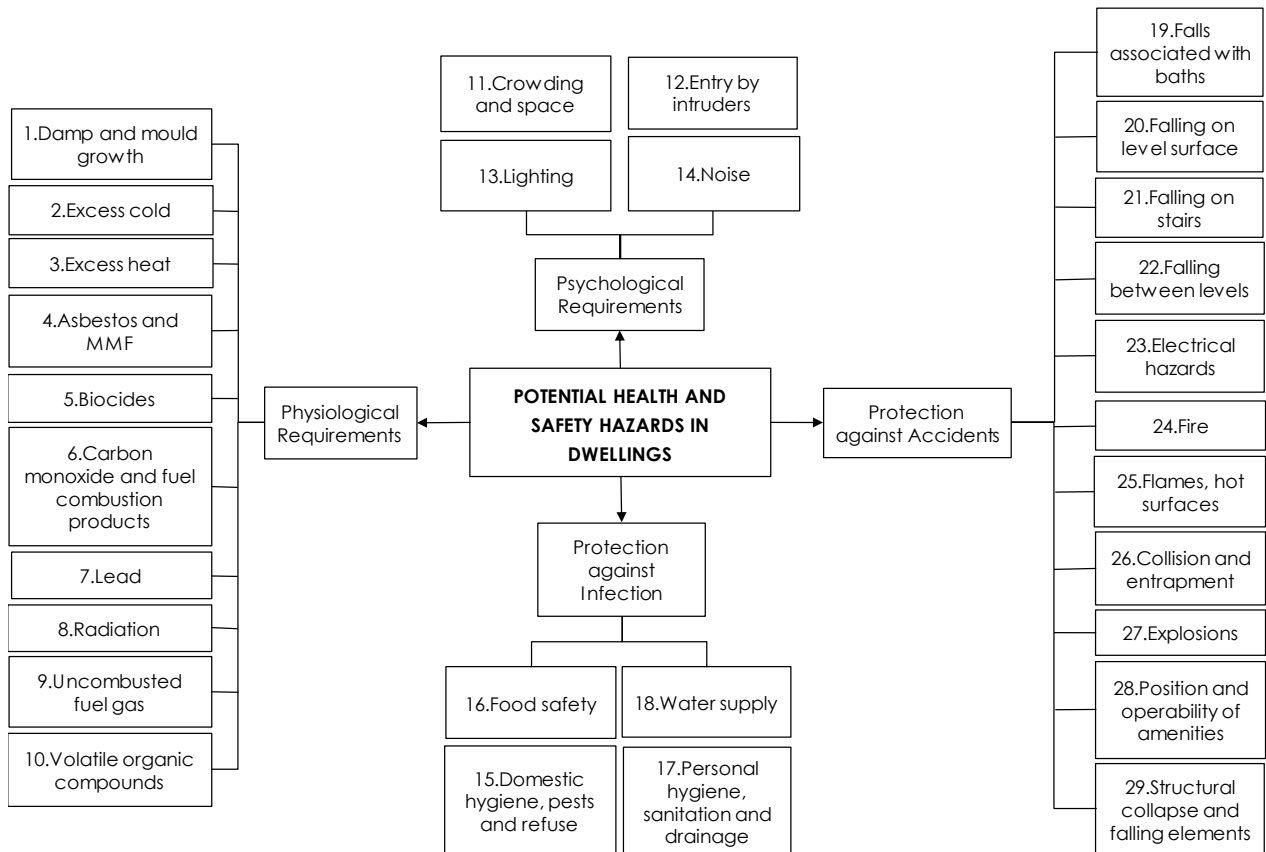


Figure 2.1. Classification of hazards in dwelling

2.2. THE MODEL

The Housing house and safety model for quantitative and qualitative analyses was developed with the goal of integrating the health, safety, technical, technological, economic, legal/regulatory, innovative, microclimatic, social, cultural, ethical, psychological, religious, ethnic and other aspects of the process over the life of the Housing house and safety. This six-stage model is presented in brief heretofore.

Stage I. Comparative description of the Housing health and safety in developed countries and in Spain (by health, safety, economic, legal/regulatory, technical, technological, organizational, managerial, quality of life, thermic, indoor quality, social, cultural, political, ethical, psychological and other aspects):

- Determining a system of 29 criteria, and around 420 subcriteria, characterizing the efficiency of a Housing health and safety by employing relevant literature and expert methods (*Figures 2.2. and 2.3.*).

- Describing, per this system of criteria, the present state of the Housing health and safety in developed countries and in Spain in conceptual (textual, graphical, numerical and such) and quantitative forms.

Stage II. Comparison and contrast of the Housing health and safety in developed countries and in Spain:

- Identifying the global development trends (general regularities) of the housing health and safety.
- Identifying the differences in housing health and safety between developed countries and Spain.
- Determining the pluses and minuses of these differences for Spain.
- Determining the best practice for the Housing health and safety in Spain as per actual conditions.
- Estimating the deviation between the knowledge stakeholders have of worldwide best practices and their practice-in-use.

Stage III. Development of certain general recommendations on how to improve the knowledge levels of stakeholders.

Stage IV. Submission of certain recommendations to stakeholders including several particular alternatives for each general recommendation proposed.

Stage V. A multiple criteria analysis of the composite parts of a Housing health and safety and selection of the most efficient life cycle for the project – henceforth interlinking the received compatible and rational composite parts of a Housing health and safety into a full Housing health and safety project.

Stage VI. Transformational learning and the redesign of mental and practical behavior.

2.3. 29 CRITERIA SYSTEM

As it was mentioned before, stage I is composed of 29 criteria system, and around 420 subcriteria, which characterize the efficiency of a Housing health and safety (*Figure 2.2. and 2.3.*). Each criteria correspond with the 29 hazards in dwellings. In this stage, it is also described each criteria.

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LT | EN | RU | [Prisijungti]

NACIONALINIO SVEIKO BŪSTO SERTIFIKAVIMO MODELIS

System description Description of alternatives Results of multiple criteria evaluation of the alternatives Lentelių sujungimas Recommendations for user

Calculation time: 1,0022007

Select objects group

- 1 Damp and Mould Growth
- 1 Damp and Mould Growth
- 2 Excess cold
- 3 Excess heat
- 4 Asbestos and manufactured mineral fibers
- 5 Biocides
- 6 Carbon monoxide and fuel combustion products
- 7 Lead
- 8 Radiation
- 9 Uncombusted fuel gas
- 10 Volatile organic compounds
- 11 Crowding and space
- 12 Entry by intruders
- 13 Lighting
- 14 Noise
- 15 Domestic hygiene, pests and refuse
- 16 Food safety
- 17 Personal hygiene, pests and refuse
- 18 Water supply
- 19 Falls associated with baths etc
- 20 Falling on level surface etc

Criteria	Points	0,01	1	4	1
Clothes drying facilities	Points	0,01	1	4	1
Damp proofing	Points	0,03	1	3	1
Disrepair to floors/walls/roofs	Points	0,03	1	1	1
Exposed water tanks and pipework	Points	0,01	3	1	1
Water using appliances	Points	0,015	1	1	1
Plumbing/waste pipes	Points	0,015	1	1	1

Figure 2.2. 29 criteria system

15 Domestic hygiene, pests and refuse

[Apie pasirinktą grupę](#)
[Normatyviniai dokumentai](#)

Qualitative and quantitative description of the alternatives:

Quantitative and qualitative information pertinent to alternatives					
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives		
			Bristol CC	CLG	IDeA
Internal walls and ceilings	points	0,002	1	1	3
External walls & roof	points	0,002	1	1	2
Ventilators	points	0,002	4	1	3
Solid floors	points	0,001	1	1	1
Suspended floors	points	0,002	1	1	2
Under floor space	points	0,002	1	1	1
Roof space	points	0,002	1	1	1
Skirting and architraves	points	0,001	1	1	1
Windows and doors	points	0,002	1	1	1
Windows and door frames	points	0,002	1	1	1
Ducts and pipework	points	0,002	1	3	3
Access to ducts	points	0,002	4	2	4
Service entry points	points	0,002	1	2	1
Water seals	points	0,002	1	1	1
Disrepair to drains	points	0,003	1	1	1
Open vent pipes	points	0,002	1	1	1
Design deficiencies	points	0,001	1	4	1
Internal refuse areas	points	0,0025	4	4	4
External refuse areas	points	0,0025	4	1	4
Refuse chutes etc.	points	0,003	4	1	4

Simbolis „()“ parodo, kad didesnis (mažesnis) kriterijaus reikšmė atitinka didesnę (mažesnę) sveikumą vartotojui (suinteresuotam asmeniui).

Figure 2.3. Subcriteria of Domestic hygiene, pests and refuse

According to the first goal of this work, to study the healthy problems that we are exposed to, the points below are dealt with the information about two of the problems to be study, lighting

and noise. It contains a short description of the hazard with some pictures, by way of example, the health effects as well as the causes. More relevant information about them is included below.

2.3.1. LIGHTING

2.3.1.1. Description of the hazard

This category covers the threats to physical and mental health associated with inadequate natural and/or artificial light. It includes the psychological effect associated with the view from the dwelling through glazing [32]. (Figure 2.4.)

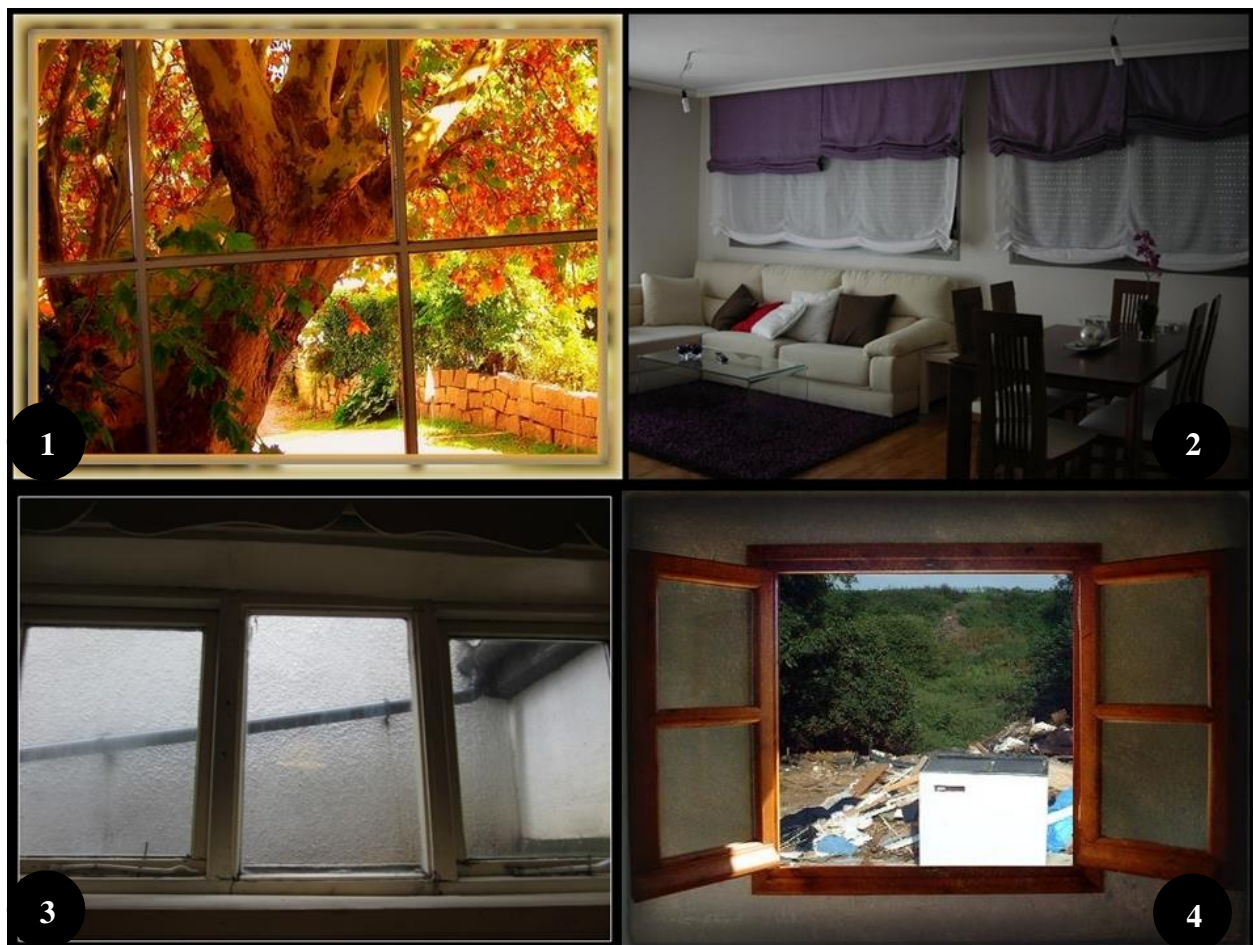


Figure 2.4. Lighting problems

2.3.1.2. Health effects

The health conditions which can be caused by inadequate light include:

- a. Depression and psychological effects caused by a lack of natural light or the lack of a window with a view.
- b. Disturbance by intrusive artificial external lighting at night.

- c. Eye strain from glare and a lack of adequate light (natural or artificial).
- d. Flicker caused by certain types of artificial light causes discomfort and may cause photo convulsive reactions to those susceptible.

The elderly and those with impaired vision are more likely to be unable to detect potential hazards, where there is inadequate or excessive light. In addition, the vision of the elderly is slow to adjust to changes in light levels [32].

2.3.1.3. Causes

- The shape, position and size of windows and the layout of rooms all affect the amount of daylight. Windows, adequate in themselves, can be obstructed externally by other buildings or by trees.
- The worst problems with lighting are often found where dwellings are located wholly at basement level. On occasions there are also problems where dwellings are entirely at attic level and are fitted solely with Velux type windows or skylights, affording no other view than the sky. This can lead to feelings of isolation.
- The siting of external lighting (street lights and security lighting) can be annoying and cause sleep disturbance to adjacent occupiers.
- Inappropriately positioned artificial lighting within the dwelling can cause glare and shadows which interfere with occupiers identifying other hazards [32].

2.3.1.4. Relevant matters affecting likelihood and harm outcome

- a. Matters relevant to the likelihood of an occurrence and the severity of the outcomes include:
- b. Obstruction – of windows by buildings or other features.
- c. Size, shape and position – inadequate size, inappropriate shape and/or position of windows preventing reasonable penetration of daylight into room.
- d. Position of artificial lighting – inadequate means and/or inappropriate siting of artificial lighting.
- e. Control of artificial lighting – lack of sufficient, accessible switches to control artificial lighting.
- f. Glare etc – artificial lighting causing glare, shadows and/or obvious flicker.
- g. Window view – inappropriate shape and/or size of window preventing view of outside.
- h. Outlook – lack of reasonable view through living room windows [32].

2.3.1.5. Hazard assessment

The assessment should include the views from windows and the adequacy of both artificial and natural lighting for the dwelling as a whole [32].

2.3.2. NOISE

2.3.2.1. Description of the hazard

This category covers threats to physical and mental health resulting from exposure to noise inside the dwelling or within its curtilage [32]. (Figure 2.5.)



Figure 2.5. Noise problems

2.3.2.2. Health effects

- a. Between 7.5 and 18% of households (that is 1.2-2.9 million) in the UK are dissatisfied because of noise from neighbours; 5.5% because of road traffic noise; and 4.0% because of people outside.
- b. The best understood effects of noise are psychological disturbances and physiological changes resulting from annoyance and sleep disturbance. Typical health effects are stress responses, sleep disorders and lack of concentration. Headaches, anxiety and irritability are also associated with noise induced stress, and the effects of sleep disturbance may affect mood the

following day. Extreme psychological outcomes include suicide, and assault due to aggravation over noise. However, hearing loss and impairment caused by noise in dwellings is unlikely.

- c. There is less certainty about the physiological effects resulting from exposure to noise, other than those linked with annoyance and stress. However, there is increasing evidence that noise causes problems without consciously awakening the individual from sleep. This noise induced arousal causes secretion of cortisol, especially in the first half of the night, and can lead to increased risk of cardiovascular disease. There is some evidence of correlation between noise and stress induced raised blood pressure and altered blood constituents.
- d. Children under combined exposure to traffic related noise and air pollution have been found to have relative risks of chronic bronchitis, asthma and skin allergies, which cannot be explained by air pollution alone.
- e. Those most vulnerable are those who are likely to spend more time at home, including the elderly, the very young and their careers. Noise causing sleep disruption will affect all groups, but particularly the elderly.
- f. Men tend to respond to noise with outwardly directed aggression, describing their feelings as annoyance, aggravation, bitterness and anger. Women tended to suppress their reactions to noise and direct them inwards, saying that they are tense, fraught or anxious [32].

2.3.2.3. Causes

- Noise in the home is a common complaint; a national noise attitude survey found that one in three people said that environmental noise disturbed their home lives to some extent.
- People vary greatly in their sensitivity and tolerance to noise. Tolerance may in part be determined by age, sex, working status, lifestyle and personality. While noise levels can be measured, people differ in what sources of noise they find offensive. Noises likely to be tolerated are from neighbours in the daytime, some traffic noise and deliveries of milk, post and newspapers. Unlikely to be tolerated are unusually loud and continuous noises which seem to go on indefinitely, noises thought to be unnecessary or inconsiderate, noises with uncertain sources, especially at night. Emotive and frightening noises, shouting and violent rows are badly tolerated.
- Residents of rented accommodation are more likely to report noise as a serious problem than owner occupiers, particularly those who rent flats.

- There are strong indications that night time traffic noise exposure is more dangerous to health than day time noise exposure.
- Poor workmanship in construction or conversion, particularly to partition and party walls, can reduce the sound attenuation properties of a structure [32].

2.3.2.4. Relevant matters affecting likelihood and harm outcome

Matters relevant to the likelihood of an occurrence and the severity of the outcomes include:

- a. Site of dwelling – located in a particularly noisy environment.
- b. Internal insulation – inadequate construction and/or insulation of floor/ceiling structure within the dwelling or between the dwelling and other premises.
- c. External insulation – inadequate levels of sound insulation to external structure.
- d. Disrepair – disrepair of windows and/or external or internal doors allowing increased noise penetration.
- e. Siting of plumbing – inappropriate siting of plumbing fittings and/or facilities.
- f. Equipment – noisy equipment or facilities.
- g. Door closers – overly powerful mechanisms resulting in banging [32].

2.3.2.5. Hazard assessment

The assessment should concentrate on the ability of the dwelling to protect the occupants from noise penetrating from outside the dwelling. The design and construction of the dwelling should protect the occupants from ordinary domestic noise from one dwelling entering another, and from traffic or other ambient external noise

It is more appropriate to assess the noise levels within the dwelling than to measure the performance of the building as this will take into account the noise conditions of the immediate environment. (In some situations the minimum required by the Building Regulations will be insufficient.) Measurement of noise levels using properly calibrated noise meters can be helpful to confirm the subjective assessment.

Noise from unreasonable behaviour of neighbours (whether domestic or commercial) should not be included in the assessment, although this could be the subject of other action [32].

2.4. DEVELOPMENT OF RECOMMENDATIONS

In stage III a certain general recommendation to improve the 29 criteria are developed.

The following points are dealt with the proposal recommendations for the two problems analysed before, lighting and noise.

2.4.1. LIGHTING RECOMMENDATIONS

- a) While fitting your apartment you should remember the following things: light from the northern part is much calmer, without shadows, it shall be used for longer working; from the southern part – blinds and forms shadows and is not very suitable for working; from the east – it is calm and suits for bedrooms and kitchens, moreover, it exalts spiritual feelings; from the west – it is warm, relaxing, suits for calming down before going to bed.
- b) Natural lighting of rooms depends on external greenery. Trees and loaches minimize flow of light. It is common for entry levels. Flow of light could also be minimized by curtains and blinds.
- c) Insufficient natural lighting shall be compensated by the artificial one. Properly selected artificial lighting could enhance viability and strengthen level of health. Still, you should remember that long-lasting staying at a bright light is undesirable; you should go out outside for a short time and stay at a daylight.
- d) Lighting intensity depends on a type of work. Writing and reading requires the intensity of about 300 lx, general lighting of a room 50-75 lx, kitchen about 100 lx, auxiliary rooms 20-50 lx. Intensive lighting could be ensured by local appliances used at a working area. Do not forget to adjust the intensity of local lighting to the lighting of the entire room. This will protect your eyes from weariness and increase work efficiency.
- e) Halls, stairs, staircases shall be sufficiently lightened by evenly distributed light flow. Stairs shall be visible; lamps shall not detain movements, engage clothes.
- f) Additional attention shall be paid to kitchen lighting. Food preparation shall be carried out in good lighting conditions in order to prevent injuries, slits, pricks. Generally, kitchens are equipped with a central lamp, maintaining background light. Local lighting shall be installed at the bottom part of dressers. It is recommended to equip the abovementioned lamps with individual switches, which could be used when the need arises. Lamp of a vapour collection hood installed above the kitchen stove emits sufficient quantity of light. The same local lighting shall be used above the sink.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

- g) Bathroom shall be equipped with general lamp installed on a ceiling, which will light the entire area of a bathroom. Closed type lamp protected from vapour and humidity accumulation shall be used. Local lighting above the mirror could be installed as well.
- h) Lighting of sitting room and dinner room could be selected individually depending on the purpose and functions of the particular room. General aspects of lighting are as follows: general lighting could be bright or calm depending on the mood, and particular areas of the room could be equipped with separate wall brackets or stand lamps. Dining table shall be lighted sufficiently.
- i) Lighting of a bedroom shall be dimmed, provided by general lamp; additional local night lamps could be used for reading and dressing up. Night lamp shall light a book and shall not disturb the sleep of a person lying next to you.
- j) Intensity of a lighting of a child's room shall be higher in comparison to the lighting of a room where parents live. For this purpose local lamps for games or homework could be used.
- k) The layout of the dwelling, particularly living rooms and kitchens, and of recreation space, should allow access for sunlight. There should be sufficient natural light during daylight hours to enable normal domestic tasks to be carried out without eyestrain. Windows should be of adequate size, and of appropriate shape and position to allow for reasonable daylight penetration into rooms. Basement and sub-ground level rooms can pose particular problems, and there should be sufficient adequate open space outside the window to allow for adequate light penetration [32]
- l) Artificial lighting should be positioned to provide sufficient light to enable domestic and recreational activities to be carried out without eyestrain and without creating glare or shadows. Artificial light is particularly important where domestic tasks require adequate light, for example in the kitchen over worktops, sinks and cookers [32]
- m) Windows should be wide enough to provide for a reasonable view of the immediate surroundings. Sills in living areas should be low enough to allow a seated person a reasonable view. (Safety glass should be provided in vulnerable locations.) Window heads should be above the eye level of someone standing. Ideally, the views should be of open space through windows of all rooms other than those where privacy is required such as bathrooms and wc compartments. The view should also provide for supervision of outside recreation space and, for security purposes, of the means of access to the dwelling [32]
- n) Avoid the absence of natural light, even with an adequate artificial light, due to the enclosing feeling that it means [26].

- o) The level of lighting should be in a uniform distribution. An unequal distribution of the lamps produce a luminous intensity variety [26].
- p) Avoid glare, controlling all existing light source in the field of vision. Using blinds or curtains on the windows, and lights with diffuser or lampshades to prevent the vision of the bright object of the light [26].
- q) The colors of the workplace should be adapted when we decorate the room: an inappropriate use of color could emphasize a pronounced contrast [26].
- r) Stairways and halls must have good general lighting for safety. To prevent accidents, stairs should be lit from top to bottom with switches in both places. For safety in hallways, place lighting fixtures every 8 to 10 feet [39].

In *Appendix I*, we can find the recommendations in Spanish (ES) and Romanian (RO) languages.

2.4.2. NOISE RECOMMENDATIONS

- a) To prevent problems from traffic and other outside noise, the level of insulation should be appropriate to the ambient noise levels. Where noise levels are high, double or secondary glazing and lobbies to external doors may be necessary. Triple glazing may be necessary close to airports or other sources of very high noise levels. Insulation of the upper floor ceiling and roof space will be important where aircraft noise is likely. However, where double or triple glazing is provided to protect occupiers from noise there must be adequate alternative provision for ventilation [32].
- b) Noise from plumbing, including from water closets and cisterns, can be reduced by siting them away from a separating wall. Bathrooms and wc compartments in flats should not be sited above living rooms or bedrooms. Separating walls and floors, particularly in flats and maisonettes, should be properly constructed to reduce impact and airborne sound transmission [32].
- c) Soundproofing against air noise: Interior partitions, facades, roof, party walls and floors in contact with the outside air in a building must have, according with the adjacent structural parts, such characteristics like: protection against the noise generated in areas belonging to the same unit used in buildings for private residential use; protection against the noise generated

in areas not belonging to the same unit used; protection against the noise generated in areas of installations and areas of activities; protection against the noise coming from outside.

- d) Soundproofing against impacts noise: The horizontal partitions must have, according with the adjacent structural parts, such characteristics like: protection against the noise generated in areas not belonging to the same unit used; protection against the noise generated in areas of installations and areas of activities.
- e) Levels of noise and vibration that installations may transmit through fasteners or contacts with others components should be limited, so that the level of noise which comes from another source, does not increase significantly.
- f) The maximum sound power level of the noise generating stationary equipment (such as burners, boilers, impeller pump, elevator machinery, compressors, generators, extractors, etc) located in enclosures of installations, and grilles and diffusers of air conditioning systems shall meet the requirements of emission levels
- g) Use building materials that contribute to the protection against noise with an appropriate acoustic properties.
- h) Fixing fences of the carpentry, in doors and windows, and skylights, as well as fixing the blinds boxes should be executed guaranteeing the air tightness.

In *Appendix I*, we can find the recommendations in Spanish (ES) and Romanian (RO) languages.

2.5. MULTIPLE CRITERIA ANALYSIS

Stage V is focused in multiple criteria analysis. There are different methods multiple criteria project analysis which help us to do a complex analysis of the research object.

Methods for performing multiple criteria analysis of the research object chosen have been developed by authors [1]: M^Ethod of complex D^Etermination of the w^Eight of the C^Riteria taking into account their quantitative and qualitative characteristics (MEDICI); Method of multiple criteria complex proportional evaluation of the projects (COPRAS); method of Defining the Utility degree and M^Arket value of a project (DUMA).

2.5.1. DETERMINATION OF THE WEIGHT OF THE CRITERIA (MEDICI)

Taking into account their quantitative and qualitative characteristics, we developed a new method for the complex determination of the weight of the criteria. This method allows one to calculate and coordinate the weights of the quantitative and qualitative criteria according to their significance and values. The weights of quantitative criteria can be coordinated if the values of the quantitative criteria are expressed through an equivalent monetary unit (Stages 1–4). Having performed a strict mutual coordination of the quantitative criteria weights, the same coordination is done with the weights of the qualitative criteria (Stages 5–7). [29]

Stage 1: The determination of the sum of values for every quantitative criteria according to

$$S_i = \sum_{j=1}^n x_{ij}, \quad i = \overline{1, t}; \quad j = \overline{1, n}, \quad (1)$$

where x_{ij} is the value of the i criteria in the j alternative of a solution; t is the number of quantitative criteria; and n is the number of the alternatives compared.

Stage 2: The total monetary expression of every quantitative criteria describing the investigated alternative is obtained by applying:

$$P_i = S_i p_i, \quad i = \overline{1, t}, \quad (2)$$

where p_i is the initial weight of the i criteria. p_i should be measured in such a way as, having been multiplied by a quantitative criteria value, an equivalent monetary expression can be obtained.

According to the quantitative criteria's effect on the efficiency of the alternative's life cycle, the quantitative criteria can be divided into:

1. Short-term factors, affecting the alternative only for a certain period of time;
2. Long-term factors, affecting the alternative throughout its life cycle.

The initial weights of long-term criteria, such as resources needed for the maintenance and environmental protection depends on the alternative's repayment time and on the evaluation, in financial terms, of a criteria's unit of measure and is

$$p_i = e f_i, \quad (3)$$

where e is repayment time of an alternative; and f_i is monetary evaluation of a measure unit of the i criteria. The initial weight of a single criteria comprising of, for example, the cost of an alternative, is equal in financial terms to the criteria's unit of measure and is

$$P_i = f_i \tag{4}$$

The meaning of the initial weight of a quantitative criteria consists of multiplying the initial weight by the value of a quantitative criteria and its monetary expression is calculated over the whole period of the alternative's repayment (equivalent to former natural expression).

Stage 3: The overall quantitative criteria magnitude's sum expressed in financial terms is determined by

$$V = \sum_{i=1}^t P_i, \quad i = \overline{1, t}. \tag{5}$$

Stage 4: The quantitative criteria weights describing the alternative, which can be expressed in financial terms, are determined as follows:

$$q_i = \frac{P_i}{V}, \quad i = \overline{1, t}. \tag{6}$$

When the above method is applied in the calculation of weights, the total sum of weights of the quantitative criteria is always equal to 1:

$$\sum_{i=1}^t q_i = 1. \tag{7}$$

Stage 5: In order to achieve full coordination between the weights of quantitative and qualitative criteria, a comparative standard of value (E) is set. E is equal to the sum of any selected weights of quantitative criteria. One of the main requirements for this comparative standard value is that according to the utility, E should be easily comparable to all the qualitative criteria. The weights of all the qualitative criteria are determined by the comparison of their utility with the standard value. E is determined according to the following equation:

$$E = \sum_{z=1}^g q_z, \tag{8}$$

where g is the number of quantitative criteria and is included into the compared standard; qz is the weight of z quantitative criteria and is included into the compared standard.

Stage 6: The initial weight vi of qualitative criteria is determined by using expert methods that compare their relative significance to the significance E of the selected compared standard. Relative weights of qualitative criteria should be expressed in percentages.

Stage 7: The weight of the i qualitative criteria is determined as follows:

$$q_i = \frac{v_i E}{100}, \quad i = t + 1, \dots, m. \quad (9)$$

The above method allows for the determination of weights of the criteria that are maximally interrelated and depend on qualitative and quantitative characteristics of all criteria.

Therefore, equivalence can be drawn between the notes of qualitative aspects and the costs of the quantitative aspects, after the establishment of the weight of each criteria [29].

2.5.2. METHOD OF MULTIPLE CRITERIA COMPLEX PROPORTIONAL ASSESSMENT (COPRAS)

The method of complex proportional assessment assumes direct and proportional dependence of the significance and utility degree of the investigated versions in a system of criteria adequately describing the alternatives and of values and weights of the criteria. A decision maker by using the experts' methods determines the system of criteria and calculates the values and initial weights of the qualitative criteria [29]

The determination of significance, priority and utility degree of alternatives is carried out in five stages [29].

Stage 1: The weighted normalized decision-making matrix D is formed at this stage. The purpose here is to receive dimensionless weighted values from comparative indexes. When the dimensionless values of the indexes are known then all criteria can be compared.

The following equation is used for this purpose:

$$d_{ij} = \frac{x_{ij} q_i}{\sum_{j=1}^n x_{ij}}, \quad i = \overline{1, m}; \quad j = \overline{1, n}, \quad (10)$$

where x_{ij} is the value of the i criteria in the j alternative; m is the number of criteria; n is the number of the alternatives compared; and q_i is weight of i criteria.

The sum of dimensionless weighted index values d_{ij} of each criteria x_i is always equal to the weight q_i :

$$q_i = \sum_{j=1}^n d_{ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}. \quad (11)$$

In other words, the value of weight q_i of the investigated criteria is proportionally distributed among all alternative versions a_j according to their value x_{ij} .

Stage 2: The sums of weighted normalized indexes describing the j th version are calculated. The versions are described by minimizing indexes S_{-j} and maximizing indexes S_{+j} . The lower the

value of the minimizing indexes such as the price of an alternative, the better the attainment of goals. Further, the greater the value of maximizing indexes such as quality, the better attainment of goals.

Sums are calculated according to

$$\begin{aligned}
 S_{+j} &= \sum_{i=1}^m d_{+ij}; \\
 S_{-j} &= \sum_{i=1}^m d_{-ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}.
 \end{aligned}
 \tag{12}$$

The greater the value S_{+j} then there is more satisfaction of the interested parties. The lower the value S_{+j} the better the attainment of goals of interested parties. S_{+j} and S_{-j} express the degree of goals attained by the interested parties in each alternative. In any case the sums of ‘pluses’ S_{+j} and ‘minuses’ S_{-j} of alternatives are always respectively equal to the sums of weights of maximizing and minimizing criteria:

$$\begin{aligned}
 S_{+} &= \sum_{j=1}^n S_{+j} = \sum_{i=1}^m \sum_{j=1}^n d_{+ij}, \\
 S_{-} &= \sum_{j=1}^n S_{-j} = \sum_{i=1}^m \sum_{j=1}^n d_{-ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}.
 \end{aligned}
 \tag{13}$$

In this way, the calculations may be additionally checked.

Stage 3: The significance of comparative alternatives is determined on the basis of describing positive alternatives S_{+j} and negative alternatives S_{-j} characteristics.

Stage 4: Determination of alternative priorities. The greater Q_j the higher is the priority of the alternative. Significance Q_j of alternative a_j indicates the satisfaction degree of demands and goals pursued by the interested parties. In this case, the significance Q_{\max} of the most rational alternative will always be the highest. The significance of all remaining alternatives is lower compared to the most efficient alternative. Total demands and goals of interested parties will be satisfied to a smaller extent than in the case of the best alternative.

Relative significance Q_j of each alternative a_j is found according to

$$Q_j = S_{+j} + \frac{S_{-\min} \sum_{j=1}^n S_{-j}}{S_{-j} \sum_{j=1}^n (S_{-\min} / S_{-j})}, \quad j = \overline{1, n}.
 \tag{14}$$

It is assumed that people can measure values of various alternatives, in terms of the so-called utility. Each alternative has its consumer or other interested party’s utility. In the proposed method, the utility of alternatives is measured quantitatively [29].

The degree of the alternative's utility is directly associated with the quantitative and conceptual information related to the alternative. If one alternative is characterized by the highest quality level and price indices, while other alternatives show better maintenance characteristics, having obtained the same significance values as a result of multiple criteria evaluation, then this means that their utility degree is also equal. With the increase/decrease of the significance of an analyzed alternative, it was found that, its degree of utility also increases/decreases. The degree of alternative utility is determined by comparing the analysed alternatives with the most efficient alternative. All the values of the utility degree related to the analyzed alternatives will range from 0% to 100% [29].

Stage 5: Utility degree N_j of alternative a_j is calculated as

$$N_j = (Q_j : Q_{\max}) 100\%, \quad (15)$$

where Q_j and Q_{\max} are the significance of alternatives obtained from Eq. (14).

In order to find what price will make an alternative of that which is being valued, competitive on the market, a method for determining the market value of alternatives based on the complex analysis of all their benefits and drawbacks was suggested. According to this method the alternatives market value of an alternative that is being estimated are directly proportional to the system of the criteria that adequately describes them and the values and weights of these criteria. This method and its practical application have been described in several publications [29].

Following the performed analysis of different multiple criteria decision making methods (TOPSIS, SAW, etc.) is it possible to make a conclusion that these methods do not show in what percent one alternative is better than another one. The suggested methods solve this problem. It is a task of the degree of utility. The degree of utility N_j of the alternative a_j indicates the level of satisfying the needs of the parties interested in the project. The more goals are achieved and the more important they are, the higher is the degree of the project utility. For example, the significance of the difference between the utility degree of first alternative ($N_1 \approx 100\%$) and the fifth alternative ($N_5 \approx 87.75\%$) shows that first alternative is more useful than fifth alternative by 12.25% (Table 2.1.) [29].

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

Criteria under evaluation	*	Weights	Measuring units	Comparable windows alternatives								
				1	2	3	4	5	6	7	8	9
Price of the window	-	1.00	Lt	0.054	0.084	0.088	0.081	0.123	0.126	0.102	0.147	0.194
Heat conductivity	-	0.90	W/m ² K	0.125	0.125	0.125	0.125	0.125	0.125	0.049	0.049	0.049
Sound insulation	+	0.50	dB	0.053	0.053	0.053	0.053	0.053	0.053	0.061	0.061	0.061
Light permeability	+	0.40	%	0.047	0.047	0.047	0.047	0.047	0.047	0.040	0.040	0.040
Light reflection	+	0.20	%	0.031	0.031	0.031	0.031	0.031	0.031	0.005	0.005	0.005
Guarantee period	+	0.30	Years	0.038	0.038	0.038	0.038	0.038	0.038	0.023	0.023	0.023
Delivery period	-	0.30	Days	0.018	0.018	0.018	0.018	0.018	0.018	0.064	0.064	0.064
Imprest	-	0.30	%	0.038	0.038	0.038	0.038	0.038	0.038	0.023	0.023	0.023
Installation price	-	1.00	%	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111
Sums of weighted normalized maximizing indices of variant S_{+j}				0.169	0.169	0.169	0.169	0.169	0.169	0.129	0.129	0.129
Sums of weighted normalized minimizing indices of variant S_{-j}				0.347	0.377	0.381	0.374	0.416	0.419	0.350	0.394	0.442
Significance of variant Q_j				0.5908	0.5555	0.5521	0.5587	0.5185	0.5156	0.5823	0.5336	0.4928
Priority of variant				1	4	5	3	7	8	2	6	9
Project's utility degree N_j (%)				100	94.01	93.44	94.56	87.75	87.27	98.56	90.31	83.41

Table 2.1. Results of windows alternatives multiple criteria analysis

Having calculated by what percent one alternative is better than another one, the developed new methods allow solving a lot of other problems. For example, it may be used as a basis for determining real estate market value (Table 2.2.).

Quantitative information relevant to construction alternatives										
Criteria describing the construction alternatives	a	Weights	Measuring units	Comparable construction alternatives						
				a_1	a_2	...	a_j	...	a_n	
Quantitative criteria	X_1	z_1	q_1	m_1	x_{11}	x_{12}	...	x_{1j}	...	x_{1n}
	X_2	z_2	q_2	m_2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}

	X_i	z_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}

Qualitative criteria	X_t	z_t	q_t	m_t	x_{t1}	x_{t2}	...	x_{tj}	...	x_{tn}
	X_{t+1}	z_{t+1}	q_{t+1}	m_{t+1}	$x_{t+1 1}$	$x_{t+1 2}$	...	$x_{t+1 j}$	...	$x_{t+1 n}$
	X_{t+2}	z_{t+2}	q_{t+2}	m_{t+2}	$x_{t+2 1}$	$x_{t+2 2}$	...	$x_{t+2 j}$	...	$x_{t+2 n}$

	X_s	z_s	q_s	m_s	x_{s1}	x_{s2}	...	x_{sj}	...	x_{sn}
...	
X_m	z_m	q_m	m_m	x_{m1}	x_{m2}	...	x_{mj}	...	x_{mn}	
Conceptual information relevant to alternatives (i.e. text, drawings, graphics, video tapes)										
C_j		C_z	C_q	C_m	C_1	C_2	...	C_j	...	C_n

^aThe sign z_i (\pm) indicates that a greater/lesser criteria value corresponds to a greater significance for interested parties.

Table 2.2. Grouped decision making matrix of construction alternative's multiple criteria analysis

The application of a Multiple Criteria Decision Support On-Line System for Construction (OLSC) allows one to determine the strengths and weaknesses of the alternatives. Calculations were made to find out by what degree one version is better than another and the reasons disclosed why it is so. Landmarks have been set for an increase in the efficiency of construction versions. All this was done argumentatively, based on indexes that were under investigation, on their values and weights and on conceptual information. This saved the users' time considerably by allowing them to increase both the efficiency and quality of construction alternatives analysis. The method for the presentation of recommendations, offered by the authors, is used for the analysis of

alternatives and for the preparation of recommendations. This has been described in several publications [29].

2.5.3. A METHOD OF DEFINING THE UTILITY AND MARKET VALUE OF A PROPERTY (DUMA)

Significance Q_j of property a_j indicates satisfaction degree of demands and goals pursued by the interested parties - the greater is the Q_j the higher is the efficiency of the property. In this case, the significance Q_{max} of the most rational property will always be the highest. The significances of all remaining property are lower as compared with the most rational one. This means that total demands and goals of interested parties will be satisfied to a smaller extent than it would be in case of the best property [35].

The degree of property utility is directly associated with quantitative and conceptual information related to it. If one property is characterized by the best comfortability, aesthetics, price indices, while the other shows better maintenance and facilities management characteristics, both having obtained the same significance values as a result of multiple criteria evaluation, this means that their utility degree is also the same. With the increase (decrease) of the significance of a property analyzed, its degree of utility also increases (decreases). The degree of property utility is determined by comparing the property analysed with the most efficient property. In this case, all the utility degree values related to the property analyzed will be ranged from 0% to 100%. This will facilitate visual assessment of property efficiency [35].

The degrees of utility of the property considered as well as the market value of a property being valuated are determined in seven stages [35].

Stage 1. The formula used for the calculation of property a_j utility degree N_j is given below:

$$N_j = \left(\frac{Q_j}{Q_{max}} \right) \cdot 100\% \quad (16)$$

here Q_j and Q_{max} are the significances of the property obtained from the equation 17.

$$Q_{j=S_{+j}} = \frac{S_{-min} \cdot \sum_{j=1}^n S_{-j}}{S_{-j} \cdot \sum_{j=1}^n \frac{S_{-min}}{S_{-j}}}, \quad j=1, n. \quad (17)$$

The degree of utility N_j of property a_j indicates the level of satisfying the needs of the parties interested in the property. The more goals are achieved and the more important they are, the higher is the degree of the property utility. Since clients are mostly interested in how much more efficient particular property are than the others (which ones can better satisfy their needs), then it is more

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

advisable to use the concept of property utility rather than significance when choosing the most efficient solution [35].

A degree of property utility reflects the extent to which the goals pursued by the interested parties are attained. Therefore, it may be used as a basis for determining property market value. The more objectives are attained and the more significant they are the higher will be property degree of utility and its market value [35].

Thus, having determined in such a way the ratio of degree of utility and market value of property, one can see what complex effect can be obtained by investing money into anyone of the property. There is a complete clarity where it pays better to invest the money and what is the efficiency degree of the investment [35].

Stage 2. The efficiency degree E_{ji} of money invested into property a_j is calculated. It shows by how many percent it is better (worse) to invest money into property a_j compared with property a_i . E_{ji} is obtained by comparing the degrees of utility of the property considered:

$$E_{ji} = N_j - N_i \tag{18}$$

The received results are presented as a matrix clearly showing utility differences of the property (*Table 2.3.*) [35].

Property considered	Utility degree deviation of a property analyzed compared to other property, %					Average deviation k_j of utility degree N_j of property a_j compared to other (n-1) property, %
	1	2	3	i	n	
a_1						k_1
a_2		12	13		1_n	k_2
a_3	21	E_{32}	23		2_n	k_3
...						...
a_j	31				3_n	k_j
...						...
a_n	j_1	j_2	j_3		j_n	k_n
	n_1	E_{n2}	n_3			

Table 2.3. Calculation of average deviations of the property utility degrees

Stage 3. The average deviation k_j of the utility degree N_j of the property a_j from the same index of other property (n-1) is being calculated.

$$k_j = \sum_{i=1}^n E_{ji} : (n - 1) \tag{19}$$

Stage 4. The development of a grouped decision making matrix for property multiple criteria analysis. The market value of a property being valuated is calculated according to a block-diagram presented in *Figure 2.6*.

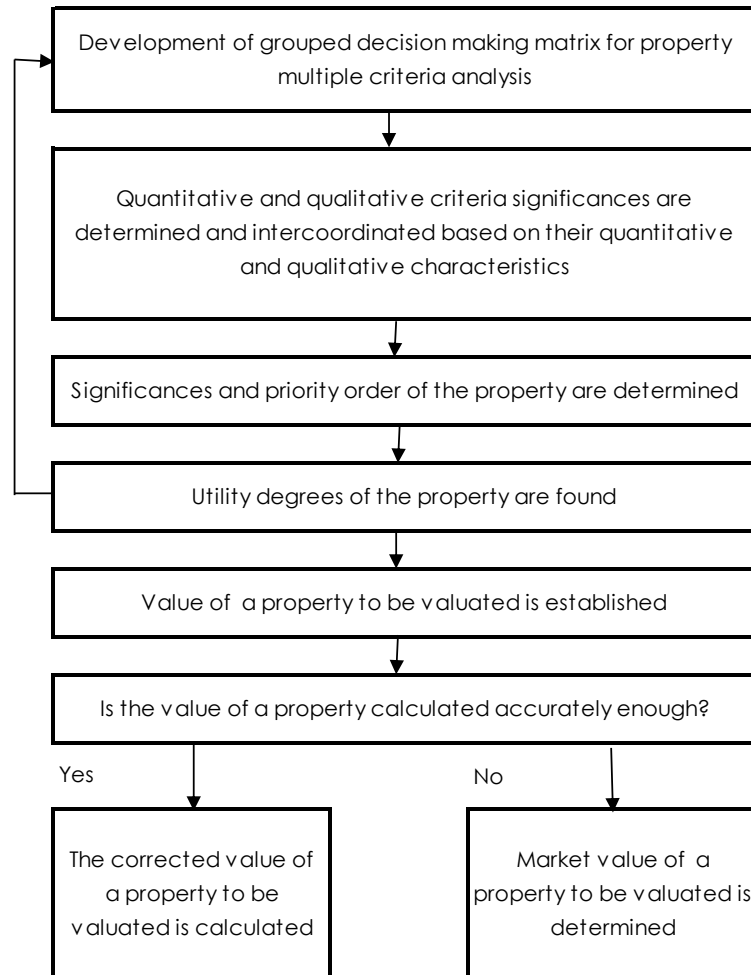


Figure 2.6. Block-diagram of property market value estimation

At the beginning, a grouped decision making matrix for property multiple criteria analysis is developed (Table x.x.), the first criterion of which is based on the actual purchasing/selling prices of the property compared and the value of a property being valuated. The initial value of a property being valuated is obtained from the following equation [35]:

$$x_{11} = \sum_{j=2}^n x_{1j} : (n - 1) \tag{20}$$

In this matrix, a property a1 to be valuated should be assigned the market value (x11-R). Other comparison standard property (a2-an) were sold, their purchasing/selling prices (x12-x1n)

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

known. All the values and significances of the criteria relating to other property are also known (table 2.4.) [35].

Criteria describing the property compared	*	Significance	Measuring units	Property to be valued and comparison standard property			
				a ₁	a ₂	... a _j	... a _n
1. Price of a property a ₁ being valued and actual purchasing/selling prices of comparison standard property (a ₂ - a _n)	Z ₁	q ₁	m ₁	X ₁₁	X ₁₂	... X _{1j}	... X _{1n}
	Z ₂	q ₂	m ₂	X ₂₁	X ₂₂	... X _{2j}	... X _{2n}

	Z _i	q _i	m _i	X _{i1}	X _{i2}	... X _{ij}	... X _{in}

Quantitative criteria	Z _t	q _t	m _t	X _{t1}	X _{t2}	... X _{tj}	... X _{tn}
	Z _{t+1}	q _{t+1}	m _{t+1}	X _{t+1 1}	X _{t+1 2}	... X _{t+1 j}	... X _{t+1 n}
	Z _{t+2}	q _{t+2}	m _{t+2}	X _{t+2 1}	X _{t+2 2}	... X _{t+2 j}	... X _{t+2 n}

	Z _i	q _i	m _i	X _{i1}	X _{i2}	... X _{ij}	... X _{in}
Qualitative criteria	...	...	...	...	...	...	...
	Z _m	q _m	m _m	X _{m1}	X _{m2}	... X _{mj}	... X _{mn}

* - The sign z_i (+ (-)) indicates that a greater (less) criterion value corresponds to a greater significance for a client

Table 2.4. A grouped decision making matrix for property multiple criteria analysis

The problem may be stated as follows: what market value x_{11-R} of a valued property a₁ will make it equally competitive on the market with comparison standard property (a₂-a_n)? This may be determined if a complex analysis of the benefits and drawbacks of the property is made [35].

Using a grouped decision making matrix (Table 2.4) and the equations 17-20 the calculations are made.

Stage 5. The corrected value x_{11-p} of a property to be valued a₁ is calculated:

$$x_{11-p} = x_{11} * (1 + k_1 : 100) \tag{21}$$

Stage 6. It is determined whether the corrected value x_{11-R} of a property being valued a₁ had been calculated accurately enough:

$$|k_1| < s, \tag{22}$$

where s is the accuracy, %, to be achieved in calculating the market value x_{11-p} of a property a₁. For example, given s = 0,5%, the number of approximations in calculation will be lower than at s = 0,1%. [35]

Stage 7. The market value x_{11-R} of a property a_1 to be valuated is determined. If inequality 2.20 is satisfied the market value of a property a_1 may be found as follows:

$$x_{11-R} = x_{11-p} \quad (23)$$

If inequality 22 is not satisfied this means that the value of a property being valuated had not been calculated accurately enough and the approximation cycle should be repeated. In this case, the corrected value $x_{11}=x_{11-p}$ of a property being valuated is substituted into a grouped decision making matrix of property multiple criteria analysis and the calculations according to the formula 17-23 should be repeated until the inequation 22 is satisfied [35].

Solving the problem of determining the market value x_{11-R} of a property a_1 being valuated, which would make it equally competitive on the market compared with the property ($a_2 - a_n$) already sold, a particular method of defining the utility degree and market value of a property was suggested. This was based on a complex analysis of all the benefits and drawbacks of the property considered [35].

According to this method the property utility degree and the market value of a property being estimated are directly proportional to the system of the criteria adequately describing them and the values and significances of these criteria [35].

CHAPTER III: Decision Support System

Based on the world wide healthy housing literature analysis [5, 12, 13, 14, 30, 32, 34, 38] and analysis of healthy housing models [4, 11, 19, 20, 21, 22, 23, 24, 28, 31, 32, 33] a National Housing health and safety Certification Model was developed. The latter may be described as follows: a life cycle of a housing health and safety, the parties involved in its design and realization as well as micro, meso and macro environment having a particular impact on it making an integral whole. A complex analysis of the research object formulated was made with the help of methods multiple criteria project analysis developed by authors [28]: Methods for performing multiple criteria analysis of the research object chosen have been developed by authors [1]: Method of complex Determination of the weight of the Criteria taking into account their quantitative and qualitative characteristics (MEDICI); Method of multiple criteria complex proportional evaluation of the projects (COPRAS); method of Defining the Utility degree and Market value of a project (DUMA); Method of Multiple criteria Multivariant design of an Alternatives (MOMMA)(Figure 3.1.).

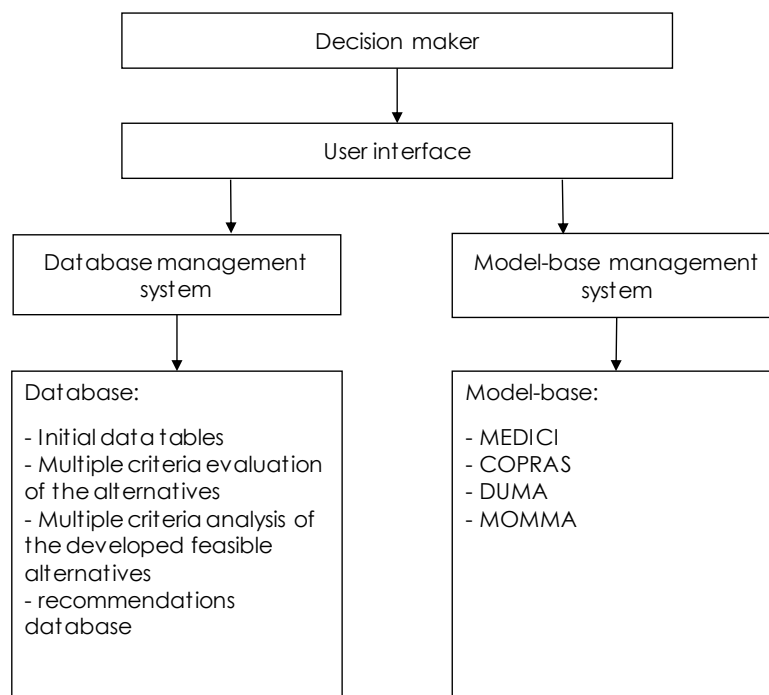


Figure 3.1. HHSRS and its composite parts

3.1. A HOUSING HEALTH AND SAFETY MULTIPLE CRITERIA DECISION SUPPORT SYSTEM

Based on the analysis of existing information, expert and decision support systems and in order to determine most efficient versions of Housing health and safety a HHS system consisting of a database, database management system, model-base, model-base management system and user interface was developed (*Figure 3.2.*).

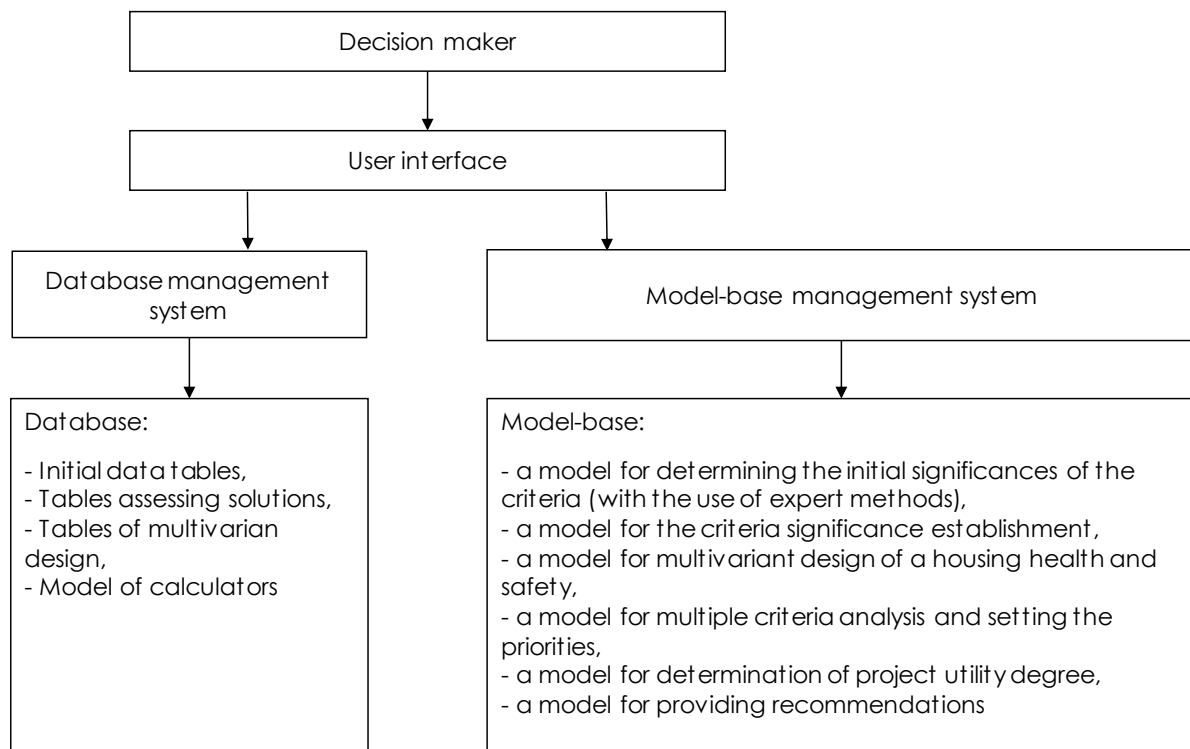


Figure 3.2. The components of HHS system

3.2. DATABASE

Housing health and safety involves a number of interested parties (i.e. clients, users, designers, contractors, suppliers, maintenance organisations, local authorities, government and its institutions, etc.) pursuing various goals as well as having different potentialities, educational level and experience. This leads to various approaches of the above parties to decision making in this field. In order to thoroughly analyse the alternatives available and obtain an efficient compromise solution it is often necessary to define them on the basis of health, safety economic, qualitative, legal, social, technical, technological and other type of information (*Figure 3.3.*). This information should be provided in a most user-oriented way.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

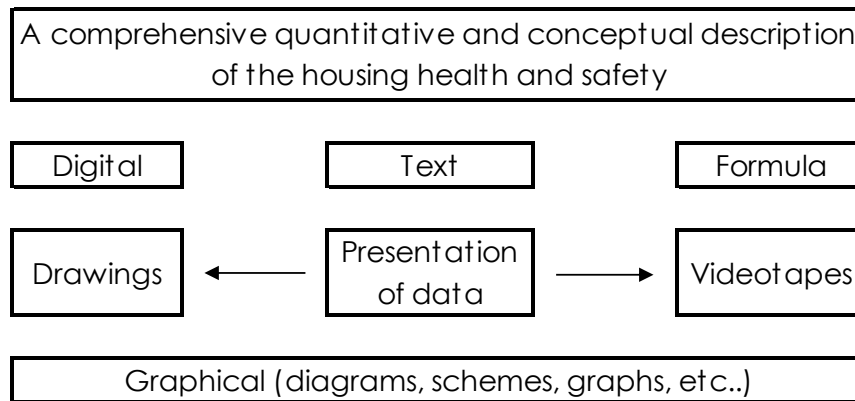


Figure 3.3. A comprehensive quantitative and conceptual description of the housing health and safety

The presentation of information needed for decision making in HHS system may be in conceptual (digital (numerical), textual, graphical (diagrams, graphs, drawing, etc), photographic, sound, visual (video)) and quantitative forms. Thus, quantitative information presentation involves criteria systems and subsystems, units of measurement, values and initial significances fully defining the variants provided. Conceptual information means a conceptual description of the alternative solutions, the criteria and ways of determining their values and significances, etc.

In this way, HHS system enables the decision maker to get various conceptual and quantitative information on housing health and safety from a database and a model-base allowing him to analyse the above factors and make an efficient solution.

The analysis of database structures in decision support systems according to the type of problem solved reveals their various utility. There are three basic types of database structures: hierarchical, network and relational. HHS system has a relational database structure when the information is stored in the form of tables. These tables contain quantitative and conceptual information. Each table is given a name and is saved in the computer external memory as a separate file. Logically linked parts of the table make a relational model. The following tables make HHS system database:

- Initial data tables. These contain the information about the 29 hazards in dwellings.
- Tables assessing health and safety recommendations. They contain quantitative and conceptual information about alternative housing health and safety solutions.
- Tables of multivariant design. They provide quantitative and conceptual information on the interconnection of the elements to be design, their compatibility and possible combinations as well as data on complex multivariant design of a building.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

The collection, processing and presentation of information for a database in the computer acceptable form is a complicated time-consuming process. The information collected in a database should be reliable, fully describing housing health and safety as well as enabling HHS system to perform an efficient multivariant refurbishment design and multiple criteria analysis.

To design the structure of a database and perform its completion, storage, editing, navigation, searching, browsing, etc. a database management system was used.

Tables of initial data contain the following 29 hazard (*Figure 3.4.*):

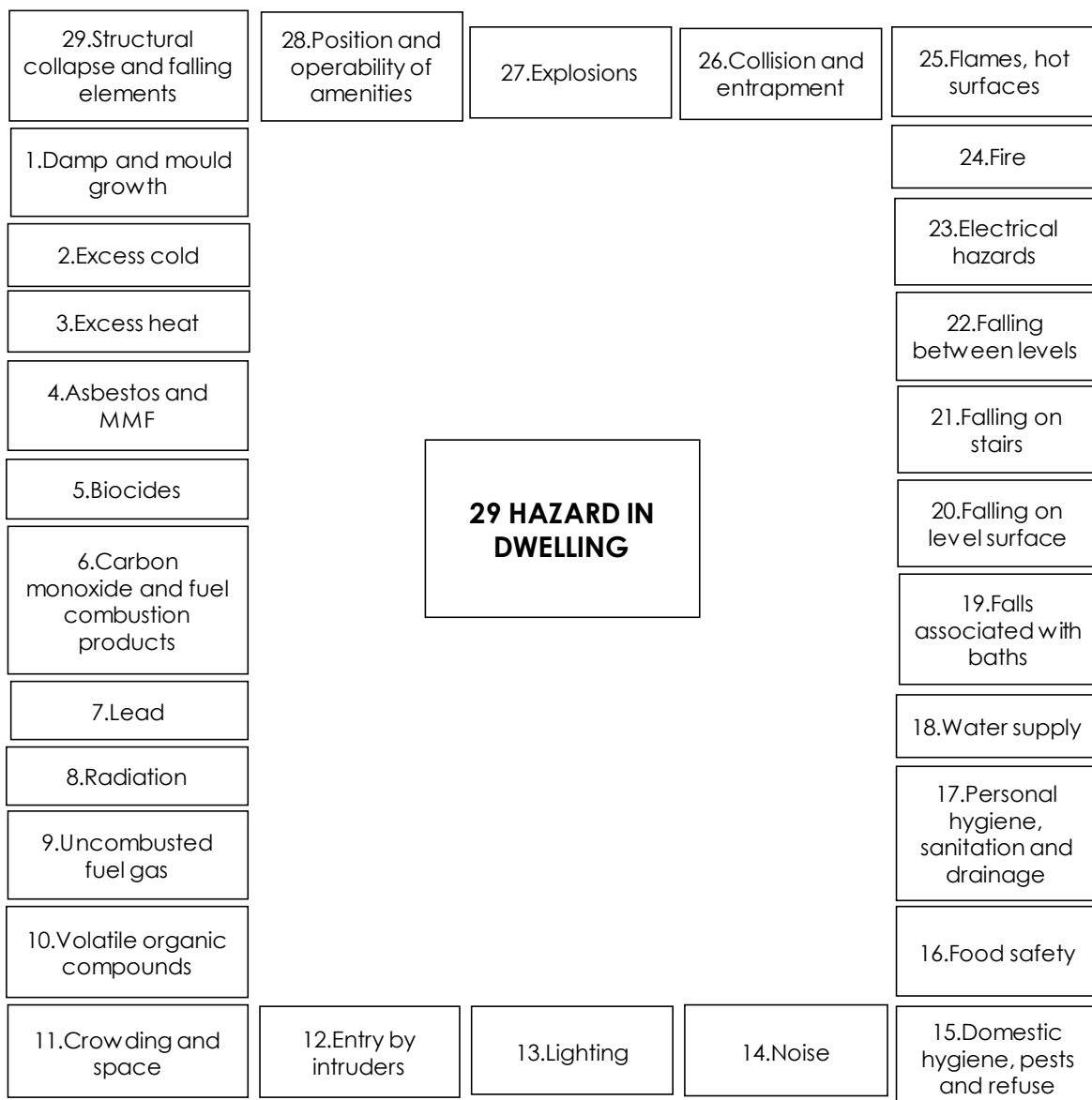


Figure 3.4. Initial data contents

The tables of variant assessment contain the variants available and their quantitative and conceptual description. Quantitative description of the alternatives deals with the systems and subsystems of criteria fully defining the variants as well as the units of measurement and values and initial significances. Conceptual description defines the alternatives available in a commonly used language giving the reasons and providing grounds for choosing a particular criterion, calculation its value, significance and the like. The process of drawing up the tables of refurbishing variant assessment consists of the following steps:

- Collection and presentation of general information about the variants under consideration,
- Establishment and conceptual description of the systems and subsystems of criteria,
- Establishing of criteria for choosing the units of measurement,
- Estimation of the values of the criteria with the description of the process of calculation and its presentation,
- Determination of the initial significances of the criteria with the description of the process of calculation and its presentation.

Based on various sources of information the variants presenting some interest to the client as well as some general facts, a system of criteria, their types (quantitative and qualitative), units of measurement and the range of value estimation are determined. The wider the range of estimating the values and significances of the criteria the more accurate analysis may be done.

The values of the criteria used to describe the alternatives are obtained by analysing the projects as well as using the expert, statistical and other methods, analogies, available recommendations and documents. The accuracy of information about the alternatives presented is of paramount importance, the objective character of the choice of the most efficient variant being largely dependent on it. It should be noted that quantitative information is sufficiently objective. Actual projects have actual costs and maintenance expenditures. The values of the qualitative criteria are usually rather subjective though the application of expert methods contributes to their objectivity. The initial significances of all criteria are obtained by using expert methods. In addition, based on various specifications and standards as well as expertise results and the client's requirements, some limitations on the criteria determining the rejection of the variants from further analysis in case the latter do not satisfy them can be established.

Uniform types of relational tables have been chosen to facilitate entering of appropriate data into the database. Such unified database also make it possible easily correct and introduce new information as well as efficiently carrying out computation.

The above tables are used as a basis for working out the matrices of decision making. These matrices, along with the use of a model-base and models, make it possible to perform multivariant design and multiple criteria evaluation of alternative building refurbishing projects resulting in the selection of most beneficial variants.

In order to design and realise an effective housing health and safety project the alternatives available should be analysed. Computer-aided multivariant design requires the availability of the tables containing the data on the interconnection of the elements to be renovated and the solutions made as well as their compatibility, possible combination and multivariant design.

Since the objectives and financial situations of HHS system users often vary the initial design data and, consequently, the results obtained will also be different. Therefore, the objectives and the financial situation of the clients are expressed quantitatively and provided as the initial data for calculations. These data should be related to the other information of the tables. Based on the above tables of multivariant building design possible refurbishment variants are being developed. When using a method of multivariant design suggested by the author until 100 000 000 alternative housing health and safety projects may be obtained. These project versions are checked for their capacity to meet various requirements. Those which can not satisfy these requirements raised are excluded from further consideration. In designing a number of variants of housing health and safety the problem of significance compatibility of the criteria arises. In this case, when a complex evaluation of the alternatives is carried out the value of a criterion significance is dependent on the overall criteria being assessed as well as on their values and initial significances.

3.2.1. DATABASE PROBLEMS ANALYSIS

This work is focused in four of the 29 problems mentioned previously: lighting, noise, domestic hygiene, pests and refuse, and electrical hazard. The points below are dealt with the information about the two problems not mentioned in *Chapter II*, domestic hygiene, pests and refuse and electrical hazard. It contains a short description of the hazard with some pictures, by way of example, the health effects as well as the causes. More relevant information about them is included below.

3.2.1.1. Domestic hygiene, pests and refuse

Description of the hazard

This category covers hazards which can result from:

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

- Poor design, layout and construction such that the dwelling cannot be readily kept clean and hygienic;
- Access into, and harbourage within, the dwelling for pests; and
- Inadequate and unhygienic provision for storing and disposal of household waste [32].



Figure 3.5. Domestic hygiene, pests and refuse problems

Health effects

- a. The potential health outcomes are gastro-intestinal disease (from spread of infection), and asthma and allergic rhinitis (from allergens). Household waste may, in addition, present a physical hazard of cuts to young children. Emotional distress is also commonly associated with pest infestations, and accumulations of refuse. Premises which are difficult to keep clean may be a cause of depression and anxiety.
- b. Insect pests can cause allergic reactions. Children who live in dwellings visibly infested with cockroaches show high levels of sensitivity to cockroach allergen. Contact with cockroaches can cause dermatitis, urticaria, rhinitis, bronchitis and asthma. Some people have an aversion

to cockroaches amounting to a phobia and can suffer anxiety when in the presence of the insects.

- c. Insects are also responsible for food spoilage, rendering it unpalatable if not inedible. Insect pests, including flies and cockroaches, are known to be mechanical vectors of diseases, picking up disease causing organisms on their bodies from one source and transferring it. Their behaviour means that they travel from matter such as rotting garbage and animal faeces that are infected to food intended for human consumption.
- d. Rats and mice are known to be infected with pathogenic organisms. Rats have been found to be infected with such zoonotic agents as *Yersinia enterocolitica* (Yersiniosis), *Listeria spp* (Listeriosis), *Cryptosporidium parvum* (Cryptosporidiosis), *Toxoplasma gondii* (Toxoplasmosis), *Leptospira spp* (Leptospirosis or Weil's disease), *Trichinella spiralis* and *Trichuris spp* (Whipworm infection).
- e. Birds, such as pigeons, can cause nuisance, carry diseases including Salmonella and can harbour biting insect pests such as the Martin Bug in their nests.
- f. All age groups may be vulnerable to infections associated with dirt, dust and those passed on by pests. Young children may be the most vulnerable to infection and cuts associated with poorly stored refuse, through lack of awareness of dangers. Asthmatics and those with pest allergies will be most vulnerable to allergic reactions to pests [32]

Causes

- Pests create a risk of cross-contamination and infection, carry disease and can infect food and surfaces. Structural defects, such as broken vents to suspended timber floors, can enable the entry of pests and rodents to the dwelling. There are also instances where rats have gnawed through plastic covers to wall ventilators. Urban rat infestations show an association with poor environments and areas of poor quality or multioccupied housing.
- Rodents are perpetual inhabitants of the sewers, from where they can readily gain access to drains. Unless prevented, they will travel from drains into dwellings where they may spoil large quantities of food both by gnawing and through indiscriminate fouling.
- Damaged or ill fitting doors and windows can provide means of access for rats and mice.
- Poorly stored food waste will attract pests including flies, cockroaches, ants, wasps, mice, rats, birds, foxes, squirrels, cats and dogs. Some of the insect pests may use the waste for harbourage, as a site for egg-laying and development of larval stages, and all can be vectors for pathogenic organisms which may breed in the food-associated waste.

- These pests may then come into contact with food before it is prepared or eaten or may come into direct contact with persons. Unless properly disposed of, the potential dangers from household waste will increase as pathogenic organisms multiply. In addition, the waste will become a source of smells.
- Multi-occupied buildings with common service ducts, and particularly those with district heating systems and consequent year-round warm conditions, can present ideal conditions for infestations of German cockroaches (*Blattella germanica*), and for tropical ants (e.g. *Monomorium pharaonis*). Treatment of infestations requires a coordinated approach to ensure pockets of infestation do not re-infest treated parts of a building.
- Service ducts and holes around pipes such as central heating pipes can provide harbourage for insects such as cockroaches and tropical ants. They may also provide routes for access between dwellings in blocks [32].

Relevant matters affecting likelihood and harm outcome

Matters relevant to the likelihood of an occurrence and the severity of the outcomes include:

- a. Internal walls and ceilings – uneven and/or cracked internal walls and/or ceilings.
- b. External walls & roof – missing or damaged brickwork, including airbricks, to external walls and other disrepair to external walls and roof.
- c. Ventilators – other unprotected ventilators to walls and/or roofs.
- d. Solid floors – uneven and/or cracked solid floors.
- e. Suspended floors – uneven and/or open-jointed boarding to suspended timber floors.
- f. Under floor space – ill fitting covers or lack of means of access to under floor spaces to facilitate treatment.
- g. Roof space – ill fitting covers or lack of means of access to roof spaces to facilitate treatment.
- h. Skirting and architraves – loose and/or ill-fitting skirting boarding or architraving.
- i. Windows and doors – ill fitting doors and/or windows.
- j. Windows and door frames – open joints between window and/or door frames and adjacent walls.
- k. Ducts and pipework – open joints to service ducting and/or pipework.
- l. Access to ducts – lack of means of access into service ducting to facilitate treatment.
- m. Service entry points – open joints to service entry points.
- n. Water seals – defective water seals to wc basins and/or drainage inlets.
- o. Disrepair to drains – including sewers and/or inspection chambers.
- p. Open vent pipes – missing guards to drainage vent pipes.

- q. Design deficiencies – harbourage points created through poor design and/or construction.
- r. Internal refuse areas – the lack of, or defects to, any internal refuse storage space.
- s. External refuse areas – the lack of, or defects to, any clearly defined area for refuse containers.
- t. Refuse chutes etc – the lack of or defects to means of disposal of refuse to each floor of multi-occupied buildings [32].

Hazard assessment

It is the overall risk at the dwelling from potential infestations and any problems associated with refuse disposal and domestic hygiene generally which is to be assessed.

3.2.1.2. Electrical hazard

Description of the hazard

This category covers hazards from shock and burns resulting from exposure to electricity, including from lightning strikes (*Figure 3.6.*)



Figure 3.6. Electrical hazard problems

Health effects

- a. When electricity passes through the human body, it causes shock to the nervous system. The shock effect ranges from mild tingling sensations to disruption of the normal regular contractions of the heart or respiratory muscles, causing death.
- b. As human tissue acts as a resistance to electricity, heat is generated which may result in burns. Such burns usually occur at the point of contact with the source of electricity. Injuries are primarily burns (53%) to the finger or thumb (58%). The mouth is the second most frequent injury site. About half of electrical accidents in the home result in burns as well as shock.

- c. The majority of injuries are not severe. Of those attending hospital accident and emergency, 38% of victims are sent home, and 47% are referred to out-patients or a GP. Of those admitted to hospital, 71% stayed for less than 3 days.
- d. Those under 40 have 80% of all accidents, and males have 59% of accidents. The most vulnerable group are young children, who are less likely to be aware of the risks posed by electricity. Boys between 5 and 14 are three times more likely to have accidents than girls of the same age [32].

Causes

- By touching metal or other conducting material which is ‘live’ a person may receive an electric shock. The risk is dependent on a number of factors, the main one being the voltage across the body. An electric shock is experienced when current passes through the body to earth.
- The majority of the electric current fatalities result from deficiencies in plugs, leads, and appliances. Less than 10% of fatalities result from a deficiency in the electrical wiring and other installations. Of the fatal accidents not associated with plugs, leads and appliances, 50% involve mains wire or cables, 24% sockets, 13% light fittings and 10% a fuse or fuse board.
- Where a location is known (62% of cases) most accidents occur in the living or dining room (27%), kitchen (23%), or bedroom (18%). For adults the location is most likely to be the kitchen or the living/dining room, for children the living/dining room or bedroom [32].

Relevant matters affecting likelihood and harm outcome

Matters relevant to the likelihood of an occurrence and severity of the outcome include:

- a. Electrical installation out-of-date – non-compliance with current requirements.
- b. Number and siting of outlets – inadequate number of, and/or badly sited electrical socket outlets.
- c. Fuses and meters – inappropriately sited fuses and meters.
- d. Earthing – lack of or inadequately earthed electrical system.
- e. Disrepair of installation – including to supply, meters, fuses, wiring, sockets, light fittings or switches.
- f. Presence of water – electrical installations in close proximity to water, including areas of damp.

Lightning protection system –lack of, or defective system to buildings at significant risk of lightning [32].

Hazard assessment

A visual inspection of the electrical installation and fixed appliances to the whole dwelling may identify obvious deficiencies which contribute to the hazard. Where there is an indication that there may be an above average risk, then a full inspection and test report by a qualified electrician or electrical engineer should be commissioned.

In multi-occupied properties, the owner or manager may provide non-fixed appliances. These should also be taken into account [32].

3.2.2. DATABASE RECOMMENDATIONS

3.2.2.1. Domestic hygiene, pests and refuse recommendations

- a) Skirting does not only very nicely hides irregularities of walls and floor, but does not let dirt to go underneath and while cleaning protect walls from stains. Profile is specifically designed to hide electrical wiring, telephone, television or Internet cables beneath it.
- b) In market exists a variety of skirting boards, so when choosing it, is advisable to take into account its characteristics, materials from which they are made, relevance to interior. Now mostly floor architraves are sold, which are molded from puffed plastic. They are lightweight, flexible, durable not only for moisture, but also for mechanical damage. They could be broken with a sharp blow, which natural wood will not bear too. Plastic skirting advantage over wood is that they will not suffer any deformation neither when they moisten, nor when dried up, also their colour will not change from the sun.
- c) The design, construction and subsequent maintenance of the dwelling should enable it to be kept clean, preventing the build-up of dirt and dust which may enable organisms to multiply. Areas of the dwelling intended for personal washing, sanitation or for food storage, preparation and cooking should be capable of being maintained in a hygienic condition [32]
- d) Walls and ceilings should be smooth and even to enable them to be easily cleaned and decorated. Walls and ceilings should be free from cracks which could provide harbourage for insect pests. Floors should be smooth and even so that they can be easily kept clean. All internal surfaces should be smooth, even and free from cracks and crevices which may allow entry by, or give harbourage to, pests. Joints between walls and floors and between walls and doors and windows should be effectively sealed. Wherever possible materials should be resistant to attack by pests, including attack by gnawing [32].

- e) The exterior of the dwelling should be free of cracks and unprotected holes. Where breaches of the walls or roof are necessary, grilles or other methods should be used to protect these [32].
- f) Any spaces within the dwelling such as service ducting, roof spaces and under floor spaces and service ducting, should be capable of being effectively sealed off from the living area. There should be means of access to these spaces for treatment in case of any infestation. Generally, dwellings should be designed and constructed so as to reduce, so far as is possible, gaps or voids that may be inaccessible to the dwelling occupants, and which may provide harbourage for pests. Particular attention should be given to the siting of such fittings as hot water tanks and boilers [32].
- g) The design and construction should reduce, so far as is possible, any means of access by pests from the outside into the dwelling. All openings into drains should be sealed with an effective water seal; this includes openings such as into the wc basin and drainage inlets for waste and surface water. To prevent mice entering there should be no holes or gaps in excess of 6.25mm. Service entry points should be effectively sealed as should any points in walls penetrated by waste, drain or other pipes or cables. There should not be any holes through roof coverings, eaves and verges which might allow access into the roof space of rats, mice, squirrels or birds. Any necessary holes for ventilation should be covered with grilles [32].
- h) There should be suitable and sufficient provision for the storage of refuse awaiting collection or disposal outside the dwelling. There should also be suitable and sufficient provision for the storage of household refuse within the dwelling. The storage provisions should be readily accessible to the occupants, but sited so as not to create a danger to children. The refuse facilities should not cause problems of hygiene, nor attract and allow access to pests [32].
- i) For houses, bungalows and houses converted to self-contained flats, there should be a clearly defined area for refuse containers. This is best in the open air, and away from windows and ventilators, and, if possible, in shade or in a shelter [32].
- j) For dwellings in purpose built blocks with not more than four storeys, refuse provision can be either by use of chutes, or by waste storage containers with free ventilation. For dwellings in purpose built blocks with more than four storeys, communal chutes are recommended (unless solid fuel appliances are installed). The chutes should discharge into large containers within a store. Any such store should be designed, constructed and maintained to reduce, as far as is possible, invasion by pests. It should also be sited, designed, constructed and maintained so as not to allow air from the store to enter any living space [32].

- k) To prevent bed bugs in our home, it is necessary: cleaning and organization of living area, reducing clutter in the home, washing sheets and blankets and drying on hot setting, encasing the mattress and box spring in a zippered encasement [17].
- l) Remove water. All living things, including pests, need water for survival. Fix leaky plumbing, and do not let water accumulate anywhere in or around your home. For example, do not leave any water in trays under your houseplants, under your refrigerator, or in buckets overnight. Remove or dry out water damaged and wet materials. Even dampness or high humidity can attract pests [37].
- m) Remove food. Store your food in sealed glass or plastic containers, and keep your kitchen clean and free from cooking grease and oil. Do not leave food in pet bowls on the counter or floor for long periods of time. Put food scraps or refuse in tightly covered, animal-proof garbage cans, and empty your garbage frequently [37].
- n) Remove or block off indoor pest hiding places. Caulk cracks and crevices to control pest access. Bathe pets regularly and wash any mats or surfaces they lie on to control fleas. Avoid storing newspapers, paper bags, and boxes for long periods of time. Also, check for pests in packages or boxes before carrying them into your home [37].
- o) Remove or destroy outdoor pest hiding places. Remove piles of wood from under or around your home to avoid attracting termites and carpenter ants. Destroy diseased plants, tree prunings, and fallen fruit that may harbor pests. Rake fallen leaves. Keep vegetation, shrubs, and wood mulch at least 18 inches away from your house [37].
- p) Remove breeding sites. Clean up pet droppings from your yard; they attract flies that can spread bacteria. Do not accumulate litter or garbage; it draws mice, rats, and other rodents. Drain off or sweep away standing puddles of water; water is a breeding place for mosquitos and other pests. Make sure drain pipes and other water sources drain away from your house [36].
- q) Take proper care of all outdoor plants. Design and maintain landscaping to limit dense ground covers and shrubs that can provide harbourage and exposed soil that may be used for burrowing. Heavy weight gravel or landscape fabric can help to discourage burrowing. Communal garden and similar areas may provide additional encouragement if they are used as eating areas and if spilt food waste is allowed to accumulate [36].
- r) In the City refuse disposal restrictions are strict and one aim of this is to ensure that rubbish is not left out (inside or outside) where pests can gain access. Refuse disposal and pickup should have a scheduled pick up time [8].

- s) Use rodent-proof refuse containers, dust bins and compactors and inspect them regularly for breakage, gaps and missing lids. Ensure that lids are properly used. Rodents are good climbers and can easily gain access to an open bin [8].

In *Appendix I*, we can find the recommendations in Spanish (ES) and Romanian (RO) languages.

3.2.2.2. Electrical hazard recommendations

- a) Voltage jumps, so-called surges, in electricity network may arise not only due to lightning. Their reasons may vary - cluttered, outdated electrical wiring, operating high-powered appliances in network. Equipment does not necessarily immediately crashes if the voltage spikes are not very large. But the all the time with small voltage fluctuations "tortured" sensitive electronic equipment after a while goes out of order or starts to malfunction.
- b) From building exploitation start 40-50 years serving electrical wiring and other equipment does not meet the fire safety requirements. Insulation is worn, wire is heating up and can cause a fire, especially if the network is overloaded. Result of electrical network overload – automatically turning off switches. Now in every household there are many domestic electrical appliances, for which there is no enough power from old electric installation to function, and the inhabitants often not considering the risk, impermissibly increase the number of outlets. Wires, connectors overload. Often overloaded network condition gets worse much faster than the uncongested one. All of this can cause a fire. In order not to exceed the loads of electrical network, in each preface of house or apartment fuses or circuit breakers are installed. If the user does not want a higher power , usually 10 A three-phase circuit breakers (they allow up to 4-5 kW load) or 16 A single-phase circuit breakers or fuses , allowing 3 kW load, are installed. If there is a single-phase 25 A fuse installed, its permissible load capacity - up to 5 kW. Under an agreement with the network operator, the contract may also provide and other powers, respectively, and other sensitivity security apparatus.
- c) Before plugging in more powerful electrical appliances (washing machines, heaters, ovens) to old electric wiring network, check the allowable wiring loads and if necessary increase their cross-sections. If the wiring load is exceeded, such household appliances must be connected to the network in separate line or it may need to increase power of network system. However, the power can be increased not by installing higher nominal current circuit breakers or fuses, but only with the electricity supplier's written authorization .

- d) Electrical cords should be replaced after 40 years of exploitation because their plastic insulation hardens and cracks, and the electrical devices - switches, sockets because of the wear of moving parts - every 30 years.
- e) Particularly a big risk is in those houses, where the two-wire electrical cables are installed because they do not have ground wire, therefore when worn are potential source of danger to life. Change or upgrade wiring can only be made by specialists with issued licenses or certifications from state-owned companies. First of all specialist will evaluate the user and his household needs, scope of work, terms and only then calculate the expenses, while agreed price will change only when the requirements of owner changes. At first specialist will ask layout scheme of electrical sockets and switches, if it does not exist, after consultation with the owner, where it intends to put furniture, he will make such scheme, calculate the required power, load, material quantities without increasing them or cheating. Specialist always will advise you where to install the main power panel, plugs or connectors. By hiring a master for electrical installation is best to use recommendations, which are got from reliable sources.
- f) With a small budget, which is used for wiring renovation, modernization of the electricity sector can be achieved in several stages: first necessary works are performed, which are related to repair works, then - all others. Although usually there is a shortage of money for electrical installation, but still it is worth choosing energy-efficient appliances. In corridors motion detector, economic lamps should be mounted, while in room – light regulators (dimmers).
- g) The simplest protection from voltage fluctuations and surges - electrical extension cords with built-in power supply filters. Some of them have a computer network and telephone connections, which are also protected from voltage fluctuations. Extenders can be used with all devices you want to protect. Before buying them you should know what sort of power devices will be connected to it and accordingly choose the appropriate extension. Protection from surges should be installed at all stages – starting with home preface, a separate apartment panel and ending with socket or by it switched terminal power filter.
- h) The potential danger of electrocution requires that there are adequate safety precautions, and, reflecting the high standard of electrical safety found in most UK homes, the incidence of electric shock in dwellings is relatively rare [32].
- i) Protection from electric shock is provided by isolation and/or insulation. Live parts must be covered with non-conducting material to reduce the risk of electric shock. All exposed metal parts of the installation must be earthed so that in the event of a deficiency any current will flow immediately to earth rendering the system safe from electric shock. Other exposed

metalwork such as gas and water pipes should also be connected to the main earth terminal [32].

- j) If equipment operating at 230 volts or higher is used, a Residual Current Device (RCD) 38 can provide additional safety. These can be incorporated in the consumer unit. An RCD is a device which detects some, but not all, deficiencies in the electrical system and rapidly switches off the supply [32].
- k) As water is highly conductive, it increases the dangers from electricity. This means that additional precautions are necessary in bathrooms, kitchens and other areas where individuals could be in contact with both water and a source of electricity (e.g. electric showers). There should be no socket outlets in bathrooms other than 12 volt AC (e.g., shaver sockets) [32].
- l) A Lightning Protection System (LPS) may need to be present where there is an unacceptable risk of a lightning strike. This is particularly relevant to tall and isolated buildings, and is part dependent on geographical location [32].
- m) Lighting of wet rooms shall be executed in accordance with the following requirements:
 - Area No. 1 – protection class IP44,
 - Area No. 2 - protection class IP24 (and IP21), and
 - Area No. 3 - protection class IP24 (and IP21).Lighting elements in area No. 1 and No. 2 shall be fixed. If the installation have been installed using insulation materials and in case in completely insulated and protected from the humidity ingress light source classification of wall brackets could be applied.
- n) Air fan shall be designed for 230 V voltage, shall be of a IP 21 protection class while installing in a wall. The receptacle shall be connected through the leak relay and shall be installed at 1.7 m height above the floor. In this case grounded devices with double insulation are permitted, for example, audio equipment, dryers, etc. Do not touch the above mentioned devices with wet hands or while being in contact with water.
- o) In a bathroom and shower room it is recommended to use grounded connectors for electrical devices such as table lamps, stand lamps, vacuum cleaners, audio equipment, dryers, ultraviolet lamps, etc.
- p) Electrical regulations foresee division of bathroom into three independent areas.
 - The first area, located above the bath, should not have power receptacles.
 - The second area could include power receptacles for electrical razors with the protection class IP24, voltage of a receptacle shall be equal to 110 V. Such receptacles shall be installed at 1.7 m height above the floor.

The third area could include grounded power receptacles of 230 V with the protection class IP21 and IP20. The receptacle shall be connected through the leak relay and shall be installed at 1.7 m height above the floor. In this case grounded devices with double insulation are permitted, for example, audio equipment, dryers, etc.

Do not touch the above mentioned devices with wet hands or while being in contact with water. Para la regulación eléctrica en los baños se divide en tres áreas independientes.

- q) Never try to repair wires with insulating tape. This tape is usually unstick and leave the wires bare again, risking anybody who touches them without realizing damaged, or even cause a short-circuit and subsequent fire [10].
- r) The iron is one of the electrical appliances should never be plugged in after use, because it overheats and probably provoke a short-circuit. It should never be plugged on clothing, even if it is just some minutes. This is one of the most common mistakes and it produce a high rate of home fires [10].
- s) All the electrical panels shall be equipped with safety systems (differential switch and circuit breaker) [16].
- t) Wires must not be placed over iron, pipes, sheet or metal furniture [16].

In *Appendix I*, we can find the recommendations in Spanish (ES) and Romanian (RO) languages.

3.3. MODEL-BASE

Since the efficiency of a housing health and safety variant is often determined taking into account health, safety, economic, aesthetic, technical, comfortability, legal, social and other factors a model-base of a decision support system should include models enabling a decision maker to do a comprehensive analysis of the variants available and make a proper choice. The following models of model-base are aimed to perform this function:

- a model for determining the initial significances of the criteria (with the use of expert methods),
- a model for the criteria significance establishment, (*figures 3.7., 3.8., 3.9., 3.10.*)
- a model for multivariant design of a housing health and safety,
- a model for multiple criteria analysis and setting the priorities,
- a model for determination of project utility degree,
- a model for providing recommendations.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

13 Lighting ▼
 Apie pasirinkta grupę
 Normatyviniai dokumentai

Qualitative and quantitative description of the alternatives:

Quantitive and qualitative information pertinent to alternatives					
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives		
			Basement/Sub-basement maisonette in a six-storey pre-1920 converted property	Basement flat under Georgian villa	Basement bedsit in a 3 storey + basement semi detached house
Obstruction	- Points	0,003	4	1	2
Size, shape and position	- Points	0,005	1	4	4
Position of artificial lighting	- Points	0,006	1	1	1
Control of artificial lighting	+ Points	0,007	4	4	4
Glare etc	- Points	0,003	1	1	1
Window view	- Points	0,002	4	4	4
Outlook	- Points	0,004	4	4	4

* The sign +/- indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Quantitive and qualitative information pertinent to alternatives					
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives		
			Possible improvement of the analysed criterion in % Galimas alternatyvos rinkos vertės padidėjimas %, įtakojamam pirmiau padidėjusios kriterijaus vertės		
			Basement/Sub-basement maisonette in a six-storey pre-1920 converted property	Basement flat under Georgian villa	Basement bedsit in a 3 storey + basement semi detached house
Obstruction	- Points	0,003	4 (75%) (7,5%)	1 (0%) (0%)	2 (50%) (5%)
Size, shape and position	- Points	0,005	1 (0%) (0%)	4 (75%) (12,5%)	4 (75%) (12,5%)

Figure 3.7. Lighting criteria example

14 Noise ▼
 Apie pasirinkta grupę
 Normatyviniai dokumentai

Qualitative and quantitative description of the alternatives:

Quantitive and qualitative information pertinent to alternatives					
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives		
			Bristol CC	CLG	IDeA
Site of dwelling	+ Points	0,01	4	1	2
Internal insulation	- Points	0,0085	1	2	1
External insulation	- Points	0,0085	1	3	2
Disrepair	- Points	0,006	1	1	1
Siting of plumbing	- Points	0,003	1	1	2
Equipment	- Points	0,002	1	2	3
Door closers	- Points	0,002	1	4	2

* The sign +/- indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Quantitive and qualitative information pertinent to alternatives					
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives		
			Possible improvement of the analysed criterion in % Galimas alternatyvos rinkos vertės padidėjimas %, įtakojamam pirmiau padidėjusios kriterijaus vertės		
			Bristol CC	CLG	IDeA
Site of dwelling	+ Points	0,01	4 (0%) (0%)	1 (300%) (75%)	2 (100%) (25%)
Internal insulation	- Points	0,0085	1 (0%) (0%)	2 (50%) (10,625%)	1 (0%) (0%)
External insulation	- Points	0,0085	1 (0%) (0%)	3 (66,67%) (14,1667%)	2 (50%) (10,625%)

Figure 3.8. Noise criteria example

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

15 Domestic hygiene, pests and refuse

[Apie pasirinktą grupę](#)
[Normatyviniai dokumentai](#)

Qualitative and quantitative description of the alternatives:

Quantitative and qualitative information pertinent to alternatives					
Criteria describing the alternatives *	Measuring units	Weight	Compared alternatives		
			Bristol CC	CLG	IDeA
Internal walls and ceilings	- Points	0,002	1	1	3
External walls & roof	- Points	0,002	1	1	2
Ventilators	- Points	0,002	4	1	3
Solid floors	- Points	0,001	1	1	1
Suspended floors	- Points	0,002	1	1	2
Under floor space	- Points	0,002	1	1	1
Roof space	- Points	0,002	1	1	1
Skirting and architraves	- Points	0,001	1	1	1
Windows and doors	- Points	0,002	1	1	1
Windows and door frames	- Points	0,002	1	1	1
Ducts and pipework	- Points	0,002	1	3	3
Access to ducts	+ Points	0,002	4	2	4
Service entry points	- Points	0,002	1	2	1
Water seals	- Points	0,002	1	1	1
Disrepair to drains	- Points	0,003	1	1	1
Open vent pipes	- Points	0,002	1	1	1
Design deficiencies	- Points	0,001	1	4	1
Internal refuse areas	+ Points	0,0025	4	4	4
External refuse areas	+ Points	0,0025	4	1	4
Refuse chutes etc.	+ Points	0,003	4	1	4

* - The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Figure 3.9. Domestic hygiene, pests and refuse criteria example

23 Electric hazards

[Apie pasirinktą grupę](#)
[Normatyviniai dokumentai](#)

Qualitative and quantitative description of the alternatives:

Quantitative and qualitative information pertinent to alternatives					
Criteria describing the alternatives *	Measuring units	Weight	Compared alternatives		
			Bristol CC	CLG	IDeA
Electrical installation out-of-date	- Points	0,005	1	4	4
Number and siting of outlets	- Points	0,003	3	4	4
Fuses and meters	- Points	0,003	3	3	1
Earthing	+ Points	5	4	2	4
Disrepair of installation	- Points	0,005	4	4	1
Presence of water	- Points	0,005	1	1	4
Lightning protection system	+ Points	0,004	4	4	4

* - The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Quantitative and qualitative information pertinent to alternatives					
Criteria describing the alternatives *	Measuring units	Weight	Compared alternatives		
			Possible improvement of the analysed criterion in %		
			Galimas alternatyvos rinkos vertės padidėjimas %, itakojamas pirmiau padidėjusios kriterijaus vertės		
			Bristol CC	CLG	IDeA
Electrical installation out-of-date	- Points	0,005	1 (0%) (0%)	4 (75%) (0,0746%)	4 (75%) (0,0746%)
Number and siting of outlets	- Points	0,003	3 (0%) (0%)	4 (25%) (0,0149%)	4 (25%) (0,0149%)
Fuses and meters	- Points	0,003	3 (66,67%) (0,0398%)	3 (66,67%) (0,0398%)	1 (0%) (0%)

Figure 3.10. Electrical hazard criteria example

Based on the above models, a HHS system can make until 100 000 000 housing health and safety alternative versions, performing their multiple criteria analysis, determining utility degree and selecting most beneficial variant without human interference.

According to the user's needs, various models may be provided by a model base management system. When a certain model (i.e. determining the initial significances of the criteria) is used the results of the calculations obtained become the initial data for some other models (i.e. a model for multivariant design of a housing health and safety, a model for multiple criteria analysis and setting the priorities), while the results of the latter, in turn, may be taken as the initial data for some other models (i.e. determining project utility degree, providing recommendations, etc.).

A management system of the HHS model base provides the user with a model base allowing him to modify the models available, eliminating those which are no longer needed and adding some new models linked with the existing ones.

In order to check the correctness of the suggested HHS system, the whole of its solution process has been more than once gone through manually. The results of manual and computer calculations matched. Besides, all separate working stages of the HHS system as well as all complex calculations have been coordinated with experts in this field - i.e. the essence of the calculations has been found to be in conformity with their logical reasoning. Owing to suggestions of these experts, some useful changes have been introduced into the HHS system. The check-up by the experts is bound with the fact that universal decision making methods are not always suitable for specific tasks and can lead to gross errors or to bad results altogether.

The more alternative versions are investigated before making a final decision, the greater is the possibility to achieve a more rational end result. Basing oneself on possessed information and the HHS system it is possible to perform multiple criteria analysis of health and safety projects components and select the most efficient versions. After this, the received compatible and rational components are joined up into projects. Having performed multiple criteria analysis of projects made up in such a way, one can select the most efficient ones. Strong and weak sides of investigated projects are also given an analysis. Facts of why and by what degree one version is better than the other are also established. All this is done basing oneself on conceptual and quantitative information.

3.4. CALCULATORS

In this point, there are various calculators that can be found on the Internet to help us to calculate the magnitude of our hazards. Most of them are for expert people, considering that we need to know some specific aspects of the field.

3.4.1. LIGHTING CALCULATOR

About lighting calculator, we can find a free application for the mobile. This application names “**EverLast® Lighting Calculator Tool Kit**”. (*Figure 3.11.*)

As we can find in the website:

http://es.appszoom.com/android_applications/productivity/everlast-lighting-calculator_cwgkq.html

EverLast® Lighting Calculator Tool Kit is the easiest way to begin your lighting audit. This app will help you realize lighting cost and maintenance savings. Once your savings calculations are complete you have the option to request a free energy analysis audit provided by EverLast® Lighting.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

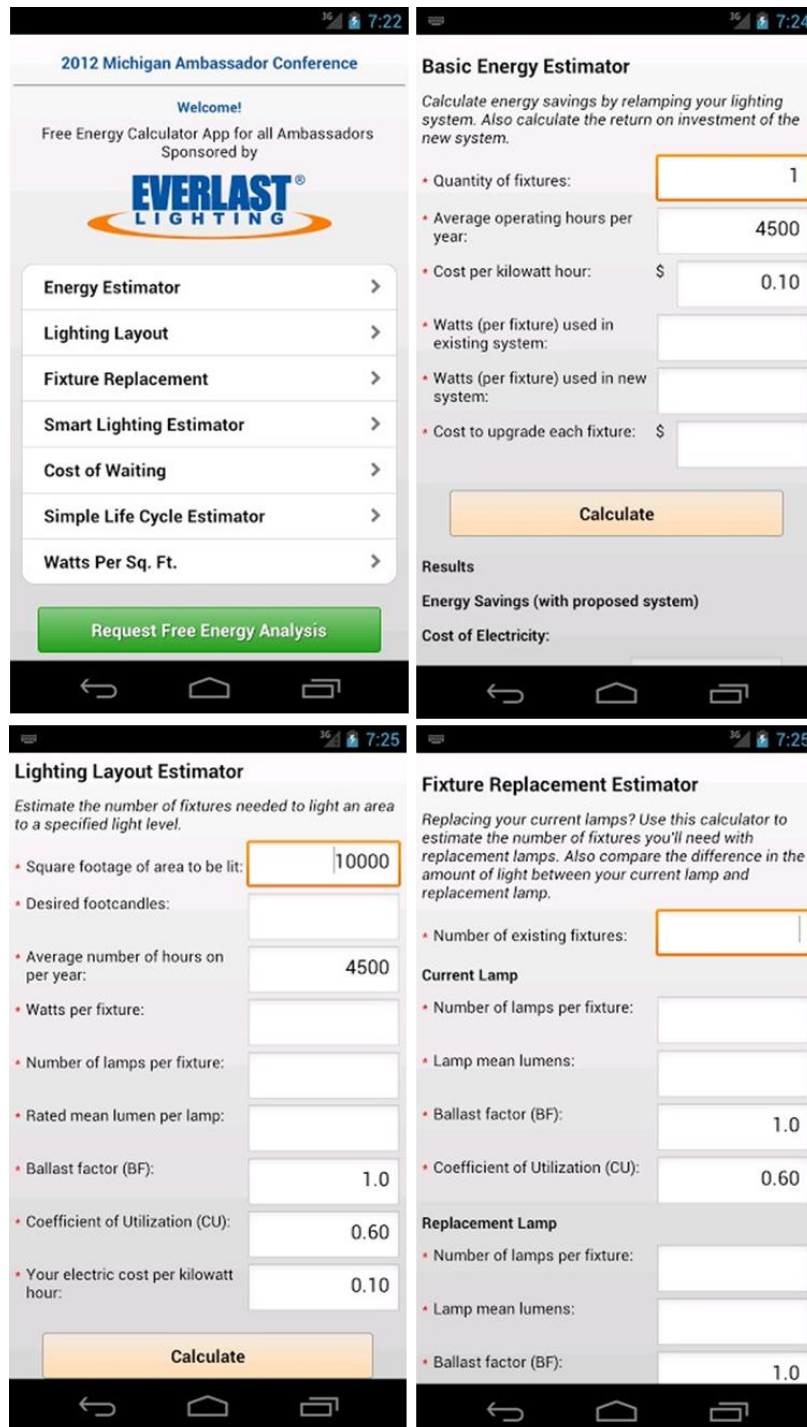


Figure 3.11. EverLast® Lighting Calculator Tool Kit

Another calculator for lighting is “DIALux” (Figure 3.12.). As we can find in its own website:

<http://www.dial.de/DIAL/en/dialux/browse/12.html>

“DIALux. The free and complete software developed by us for professional light planning is open to luminaires of all manufacturers. A software by planners for planners. Used by many

hundredthousands of light planners and designers worldwide. And their number is growing from day to day.

Create your virtual worlds simply and intuitively with DIALux. Document your results in breath-taking, photorealistic visualizations. Delight your customers with daylight and artificial light scenarios through which they can glide with wild camera runs. Rely on the CAD data of other architecture programmes and re-export your files easily. Or use any 3D models from the Internet – it's child's play.

While you plan creatively, DIALux determines the energy your light solution requires and supports you in complying with the respective national and international regulations.

DIALux is continuously being developed by a team of 20. You can plan in DIALux with the luminaires of the world's leading manufacturers and therefore have the greatest possible freedom in the design process. And the the list of international partner companies is getting longer and longer.”

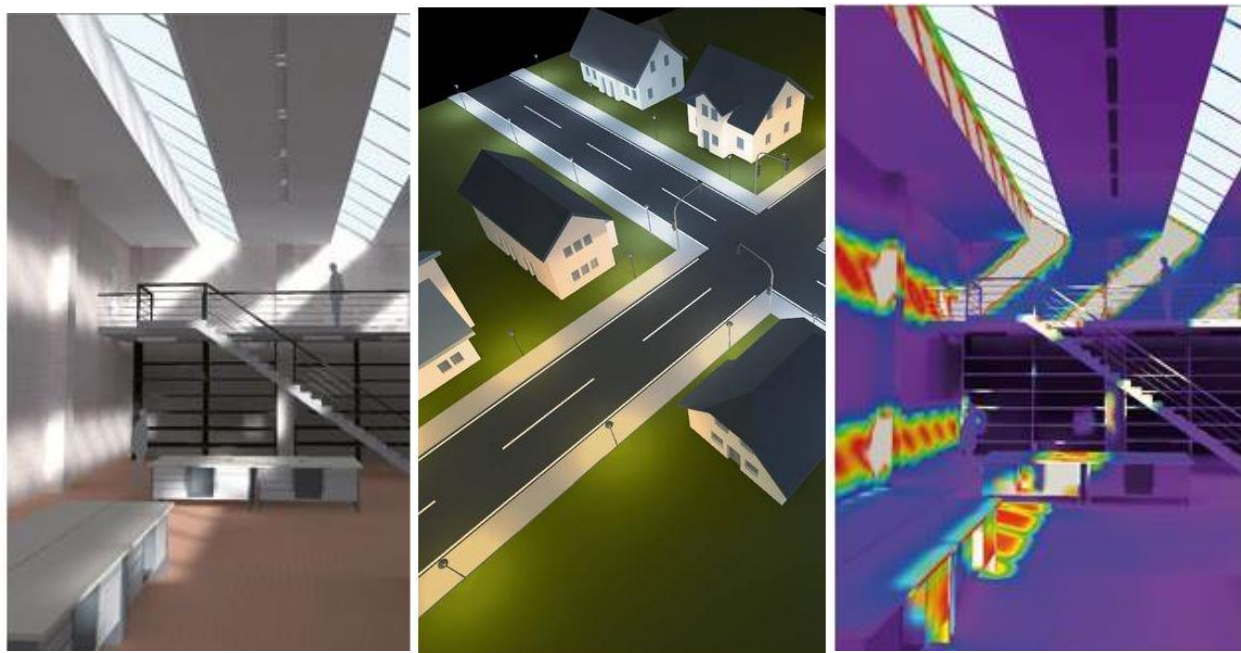


Figure 3.12. DIALux

3.4.2. NOISE CALCULATOR

About noise calculator, can be found a cool, interactive calculation utility for handling common acoustical and decibel calculations. It is “**noiseLAB Calculator**”. (Figure 3.13.)

This program has a trial demo free, available in this website:

<http://noiselabdk.wordpress.com/demo-download/download-trial/>

This calculator include:

- Sum multiple sound levels, also time-weighted
- Add an arbitrary number of equal level sound sources
- Subtract dB/Correct for background noise
- dB to Pascal and Microphone sensitivity in dB or mV/Pascal
- dB to Volts to Percentage
- Free field propagation

and noiseLAB Calculator is unique because most computations work forward and backwards, i.e. key in any field and the other fields are computed automatically.

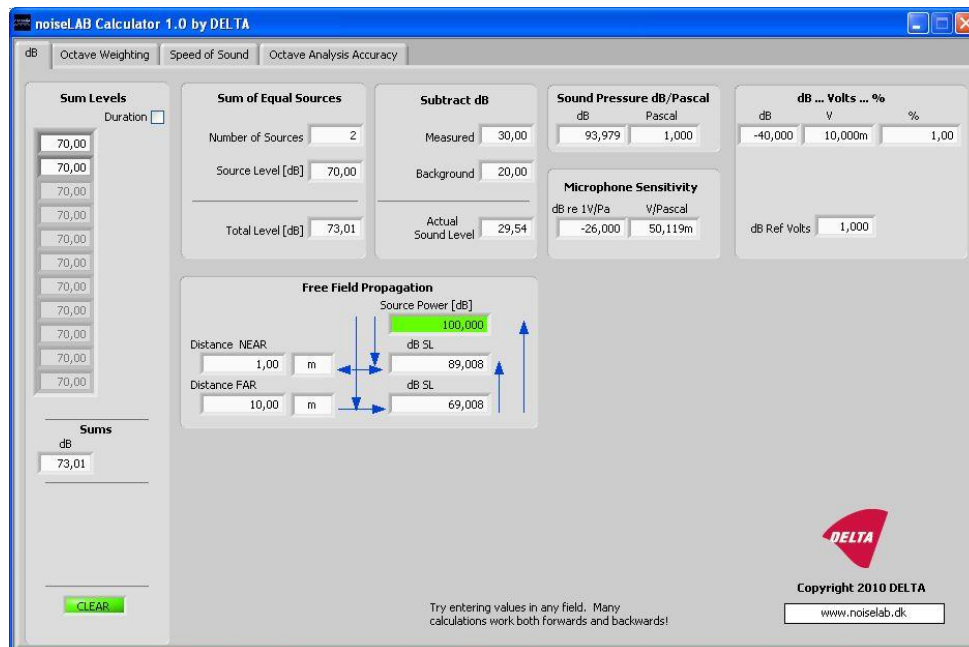


Figure 3.13. NoiseLAB Calculator

The next calculator is “**Noise Calculator**”. (Figure 3.14.). As we can see in the website: <http://sourceforge.net/projects/noisecalculator/>

This program is for estimating Lden (dB(A)) noise levels of traffic, train, road, and windturbine noise depending of many variables using the latest EU guidelines (2002/49). Still beta version so any feedback welcome.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

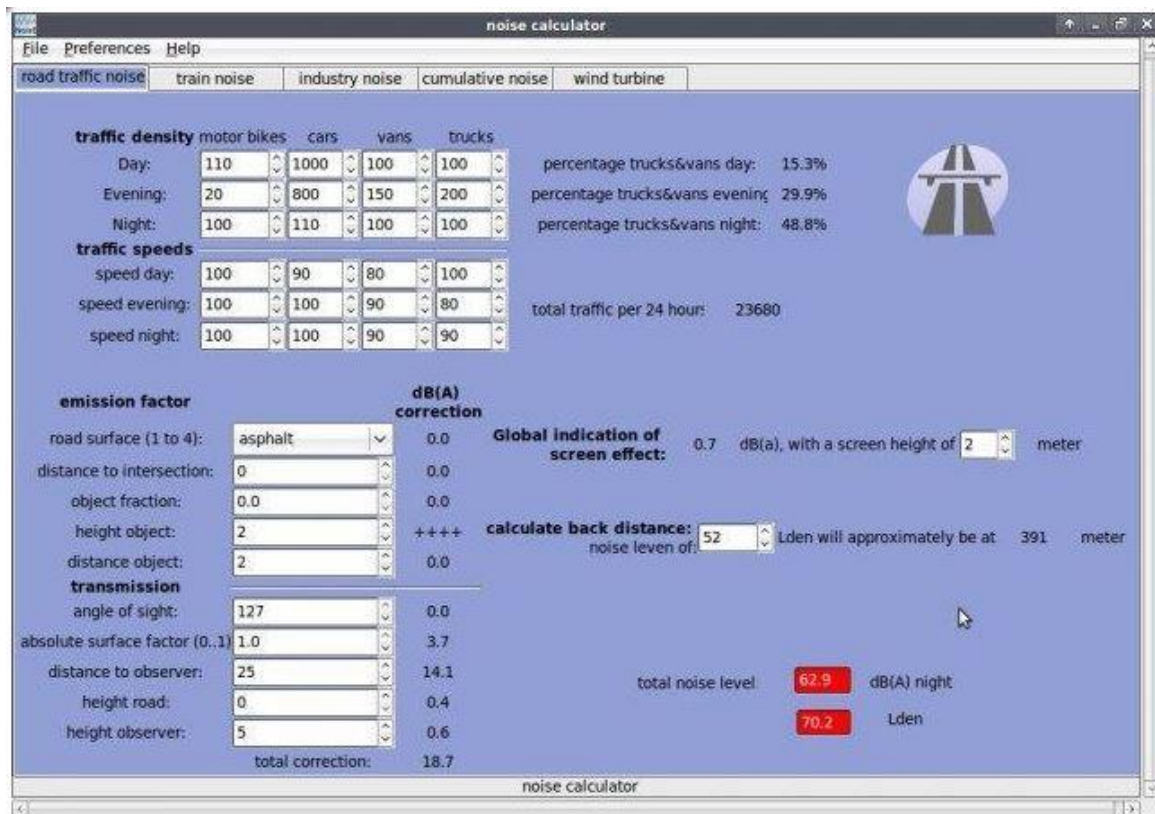


Figure 3.14. Noise Calculator

3.4.3. ELECTRICAL CALCULATOR

About electrical calculator, can be found “**Electrical Tools (E-Tools)**”. (Figure 3.15.)

As we can see in the website:

http://www.elitesoft.com/web/electrical/elite_etoools_info.html

“*Electrical Tools (E-Tools) provides 14 common electrical calculation and data look-up tasks. These tasks include wire sizing, conduit sizing, motor equipment sizing, panel sizing, lighting requirements (in metric or English units), current to power conversion, Ohm's Law calculator, capacitor sizing, voltage drop, short circuit, and the quick look-up of many electrical formulas and conversion factors. Results are instantly displayed on the screen as data is entered. Some of the functions in E-Tools are also covered by other Elite programs. For example, E-Tools will calculate the voltage drop for up to five components with their associated kVA loads. Our V-Drop program will calculate the voltage drop for networks containing up to 2,000 components and kVA loads. The same situation exists with the short circuit and luminaire requirement calculations. Elite has other programs you may want to consider that address those applications on a complete system basis*”.

We can obtain a trial demo free, available the website.

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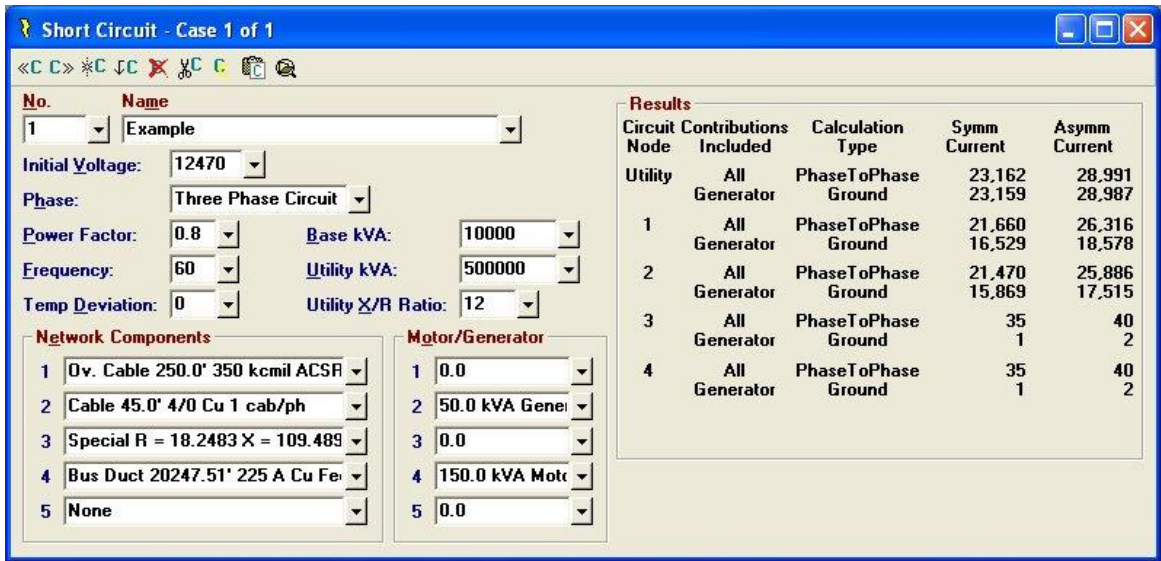


Figure 3.15. Electrical Tools (E-Tools) Calculator

CHAPTER IV: Case study

In this chapter we have developed an interactive tool of easy access for expert and non-expert users of construction, in which we find the problems mentioned above: how these damages could have been produced (through pictures), where we could find them, and also a link to a program with the online recommendations.

4.1. CREATION OF A VIRTUAL HOUSE

Firstly, a simple dwelling was chosen as example. In this case, the chosen dwelling was a small flat located in the center of Vilnius, the capital of Lithuania. The dwelling has a corridor, bathroom, bedroom, livingroom and kitchen (the latter two are in the same space). Pictures of the entire room have been taken, from the floor up to the ceiling, with the aid of a tripod located around the middle of each room.

Once all the pictures were taken, the following step was to create a panoramic view of all the rooms using the program “Kolor Autopano Giga 3.0” (Figure 4.1.).

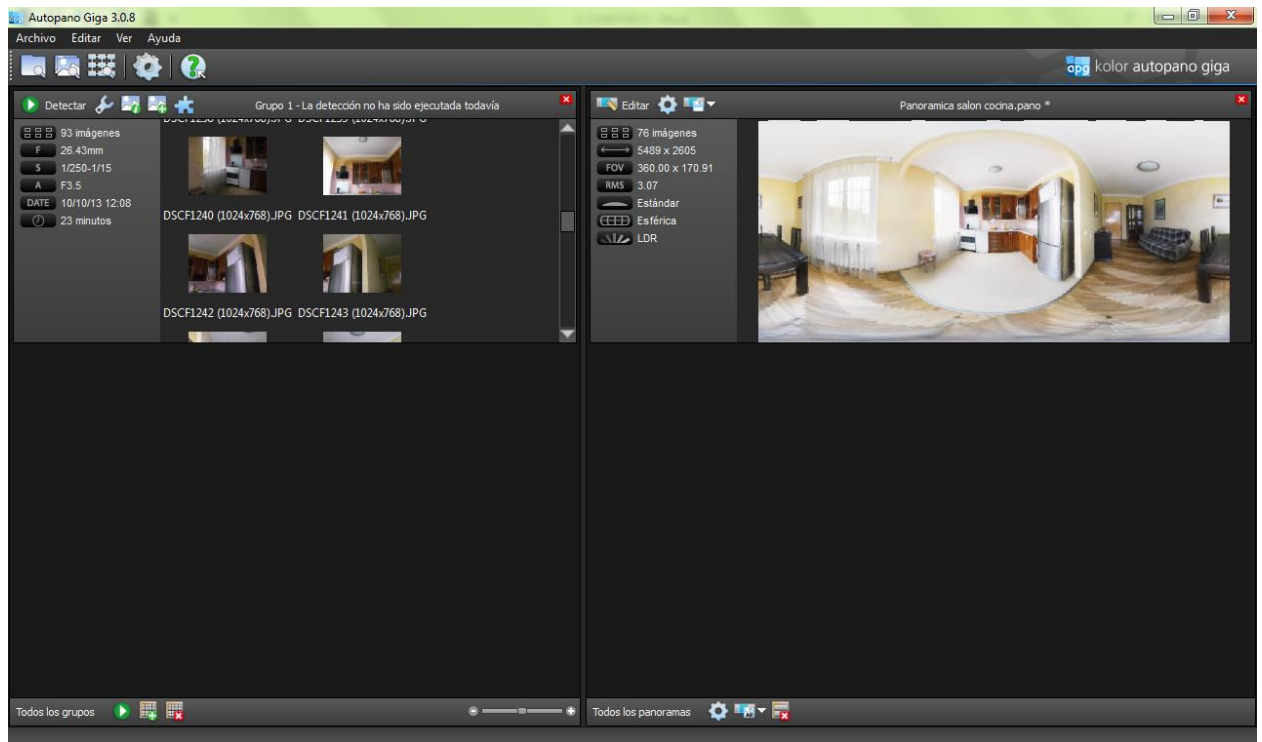


Figure 4.1. Kolor Autopano Giga 3.0 program

In the following picture (Figure 4.2.), we observe the panoramic views created of the corridor, bathroom, bedroom and livingroom-kitchen, in that order:

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD



Figure 4.2. Panoramic views created

Once we created all the panoramic views, the following task was to produce the virtual tour with another program. In this case, “*Kolor Panotour Pro 1.8*” was used. (Figure 4.3.)

It was necessary to create different links among the panoramas to produce the tour. To do it, one only needs to insert a few hotspots in all the rooms and link them all accordingly.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

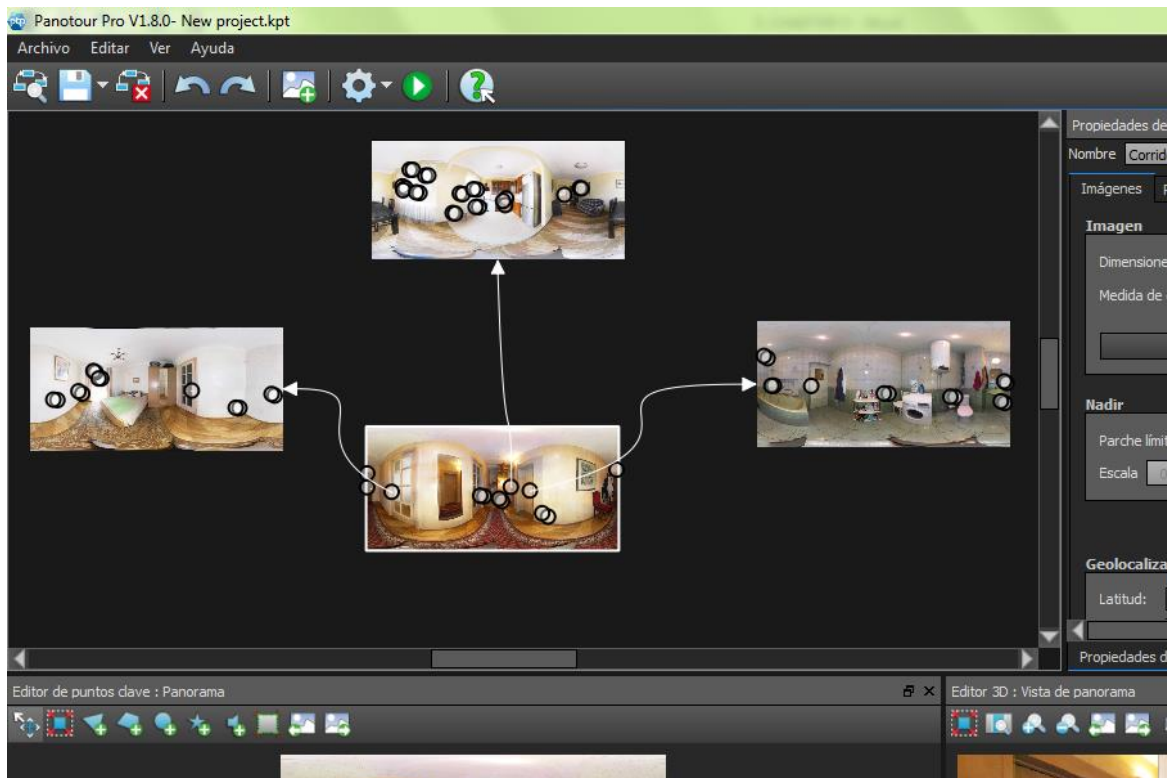


Figure 4.3. Kolor Panotour Pro 1.8 program

After linking the panoramas correctly, the last step was to build the tour.

4.2. VIRTUAL HOUSE INTELLIGENT SYSTEM

The purpose of this, as it was mentioned before, is to create an interactive tool in which we find the problems.

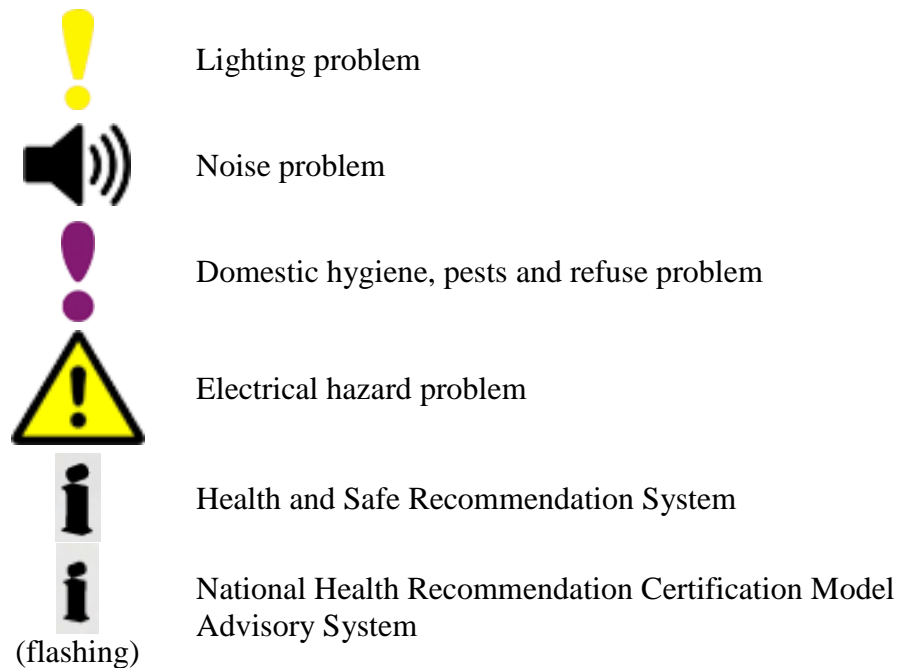
Opportunity to add particular objects in to the vision is foreseen in Kolor Panotour, i.e. you could add descriptions of objects incorporated into the tour or panorama (e.g., by clicking on the additional object installed on a wall you could review information about materials used in construction or finishing of the house), photos, sound tracks, video clips, flash or other elements of multimedia. Thus, we added several hotspots, in which we inserted an image of the possible problem. And next to them, another three hotspots with an external link, one of them is to “Health and Safe Recommendation System”

[<http://iti.vgtu.lt/imitacijosmain/simpletable.aspx?sistemid=517>], the other is to “National Health Recommendation Certification Model Advisory System”

[<http://iti.vgtu.lt/ilarning/kapateikti.aspx>], and the other is to the website of the calculator, which was talked about it in *Chapter 3.4.*, corresponding to the hazard.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

For each kind of problem we used a different icon to identify it in the virtual tour, and when you click on each one, the corresponding image appears. The icons used for each problem were:



Once the images and the corresponding external links to the recommendations and calculators were inserted, the final tour was built and uploaded to a server of Vilnius Gediminas Technical University.

[http://iti.vgtu.lt/imitacijosmain/oana_fatima1.swf]

In the following pictures (*Figure 4.4., 4.5., 4.6.*), we observe some screenshots of the Virtual House Intelligent System, as the final result.

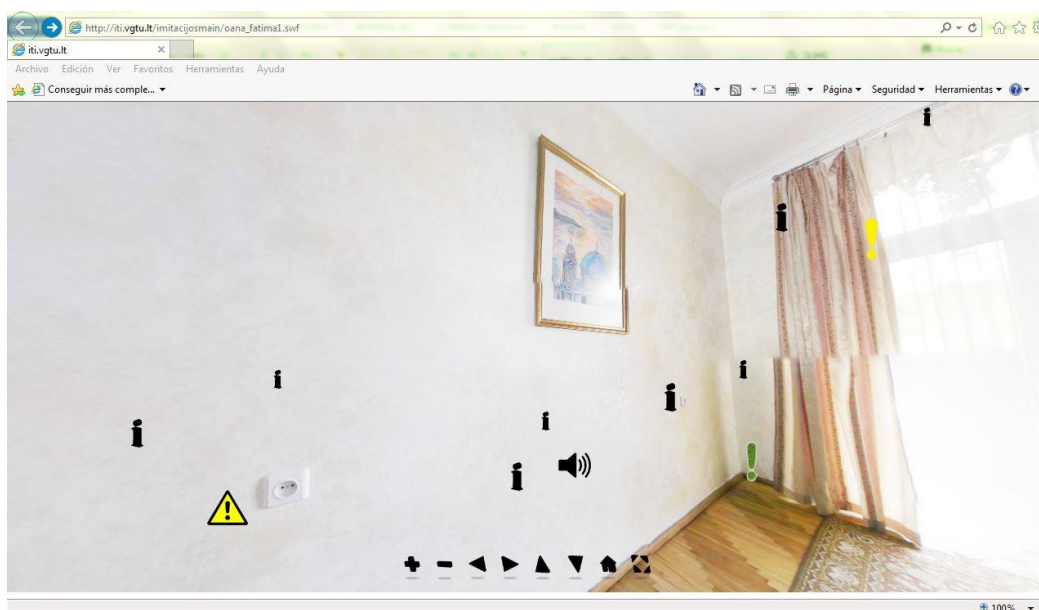


Figure 4.4. Virtual House Intelligent System - Bedroom

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

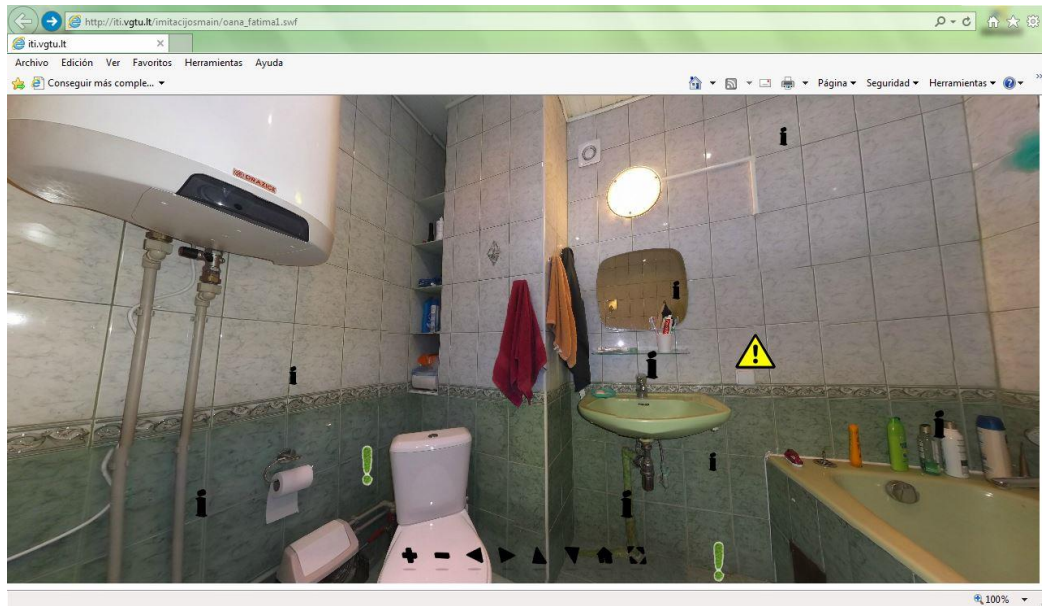


Figure 4.5. Virtual House Intelligent System - Bathroom

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

The screenshot displays the Virtual House Intelligent System interface. It features a 3D model of a house with various icons indicating different types of hazards or issues. A red box highlights a speaker icon, which is linked to a video showing a busy street scene. Another red box highlights a warning icon, which is linked to a video showing a residential area with a fence. The interface also includes a 'PRACTICAL TUTORING SYSTEM' section with a table of noise alternatives and a 'Kompiuterinēs mokymosi sistēma' section with a list of noise-related questions.

Quantitative and qualitative information pertinent to alternatives			
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives
			Bristol CC CLG JDeA
Site of dwelling	Points	0.01	4 1 2
Internal insulation	Points	0.0085	1 2 1
External insulation	Points	0.0085	1 3 2
Disrepair	Points	0.006	1 1 1
Siting of plumbing	Points	0.003	1 1 2
Equipment	Points	0.002	1 2 3
Door closers	Points	0.002	1 4 2

Are neighbours noisy?
 Is there the source of noise inside the premises? (conditioner, computer, etc.)
 Can the source of noise be removed/eliminated?
 Do you use any means for protection against noise?
 Is there any heavily loaded traffic, noisy street, railway in the vicinity?
 Is your house situated close to the airport?
 Do you live in the centre of the city?
 Is the distance to the noise source not long?
 Are there any partitions protecting against the noise source?
 Do you have any possibility to appeal for support to the municipality?

Figure 4.6. Virtual House Intelligent System – Noise example

CHAPTER V: User manual

5.1. OPERATION MANUAL FOR VIRTUAL HOUSE INTELLIGENT SYSTEM

Virtual tours are being developed by joining photographs into 3D (spherical) panorama, and separate panoramas into single system, enabling direct tour through panoramas. Using keyboard buttons ◀▶▲▼ you could view the entire space about, under or above you. You could zoom in or out all required objects. The user could directly go through view points and the entire real property facility. Consequently, the unified excursion (tour) feeling without going out from home could be formed (e.g. from one room to another, viewing the entire house).

Created virtual recommendation could be found at http://iti.vgtu.lt/imitacijosmain/oana_fatima1.swf. Going through rooms of the house could be performed by clicking the “key” icon placed at the door. Apartment includes additional elements showing information about potential problems which could occur at the precise part of the construction, for example, noise or electrical hazard. Each group of problems is displayed by different element, clicking on which could enable you to view figure with description of a particular problem. “i” icon for information is also located near the element of the problem. In our case the “i” icon will redirect you to the support system for decision making [<http://iti.vgtu.lt/imitacijosmain/simpletable.aspx?sistemid=517>], which provides reasons of occurred problem and its solution or minimization methods. Each group of problems has its own address which will be launched upon clicking the “i” icon near the figure of the problem. Clicking on flashing “i” icon will redirect you to the advisory system in accordance with foreign recommendations [<http://iti.vgtu.lt/ilarning/kapateikti.aspx>].

5.2. OPERATION MANUAL FOR HEALTH AND SAFE RECOMMENDATION SYSTEM

Health and Safe Recommendation System could be launched at: <http://iti.vgtu.lt/imitacijosmain/simpletable.aspx?sistemid=517>. Health and Safe Recommendation System includes 29 facility groups (*Figure 5.1.*): humidity and mould, excessively low temperature, excessively high temperature, asbestos and artificial mineral fibre, biocides, etc. The user could enter the main data matrix of every facility group by clicking “Description of alternatives” (*Figure 5.2.*).

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

Select objects group

1 Damp and Mould Growth
2 Excess cold
3 Excess heat
4 Asbestos and manufactured mineral fibers
5 Biocides
6 Carbon monoxide and fuel combustion products
7 Lead
8 Radiation
9 Uncombusted fuel gas
10 Volatile organic compounds
11 Crowding and space
12 Entry by intruders
13 Lighting
14 Noise
15 Domestic hygiene, pests and refuse
16 Food safety
17 Personal hygiene, pests and refuse
18 Water supply
19 Falls associated with baths etc
20 Falling on level surface etc
21 Falling on Stairs etc.
22 Falling between levels
23 Electric hazards
24 Fire
25 Flames, hot surfaces etc.
26 Collision and Entrapment
27 Explosions
28 Position and Operability of Amenities etc
29 Structural Collapse and Falling Elements
30 Kvapai

Figure 5.1. Facility groups of Health and Safe Recommendation System

System description
Description of alternatives
Results of multiple criteria evaluation of the alternatives

Multiple criteria analysis of the developed feasible alternatives
Recommendations for user

Calculation time: 2,0250051

Select objects group

15 Domestic hygiene, pests and refuse

[Apie pasirinkta grupę](#)
[Normatyviniai dokumentai](#)

Qualitative and quantitative description of the alternatives:

Quantitative and qualitative information pertinent to alternatives						
Criteria describing the alternatives	Measuring units	Weight	Compared alternatives			
			Bristol CC	CLG	IDeA	
Internal walls and ceilings	Points	0,002	1	1	3	
External walls & roof	Points	0,002	1	1	2	
Ventilators	Points	0,002	4	1	3	
Solid floors	Points	0,001	1	1	1	
Suspended floors	Points	0,002	1	1	2	
Under floor space	Points	0,002	1	1	1	
Roof space	Points	0,002	1	1	1	
Skirting and architraves	Points	0,001	1	1	1	
Windows and doors	Points	0,002	1	1	1	
Windows and door frames	Points	0,002	1	1	1	
Ducts and pipework	Points	0,002	1	3	3	
Access to ducts	Points	0,002	4	2	4	
Service entry points	Points	0,002	1	2	1	
Water seals	Points	0,002	1	1	1	
Disrepair to drains	Points	0,003	1	1	1	

Figure 5.2. Description of alternatives of Health and Safe Recommendation System

Every parameter has its own description, including its rating, minimization/maximization opportunities, and criterion weight. Estimated alternatives to be compared inter se are provided as well.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

Main data matrix could be normalized upon clicking the “Assessment results for several matrixes” and the system itself could provide values of alternatives, ratings and coefficient of efficiency (%) (Figure 5.3.). Performed calculations have shown that the healthiest recommendation in terms of moulds and humidity level is Bristol CC recommendation (100 %). Calculations for other groups are carried out by analogy.

System description		Description of alternatives		Results of multiple criteria evaluation of the alternatives			Lentelių sujungimas
Multiple criteria analysis of the developed feasible alternatives				Recommendations for user			
Calculation time: 1.2661277s							
Select objects group							
15 Domestic hygiene, pests and refuse							
Apie pasirinkta grupę Normatyviniai dokumentai							
Quantitative and qualitative information pertinent to alternatives							
Criteria describing the alternatives	*	Measuring units	Weight	Compared alternatives			
				Bristol CC	CLG	IDeA	
Internal walls and ceilings	-	Points	0,002	0,0004 AVG MIN	0,0004 AVG MIN	0,0012 AVG MIN	
External walls & roof	-	Points	0,002	0,0005 AVG MIN	0,0005 AVG MIN	0,001 AVG MIN	
Ventilators	-	Points	0,002	0,001 AVG MIN	0,0002 AVG MIN	0,0008 AVG MIN	
Solid floors	-	Points	0,001	0,0003 AVG MIN	0,0003 AVG MIN	0,0003 AVG MIN	
Suspended floors	-	Points	0,002	0,0005 AVG MIN	0,0005 AVG MIN	0,001 AVG MIN	
Under floor space	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Roof space	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Skirting and architraves	-	Points	0,001	0,0003 AVG MIN	0,0003 AVG MIN	0,0003 AVG MIN	
Windows and doors	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Windows and door frames	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Ducts and pipework	-	Points	0,002	0,0003 AVG MIN	0,0009 AVG MIN	0,0009 AVG MIN	
Access to ducts	+	Points	0,002	0,0008 AVG MIN	0,0004 AVG MIN	0,0008 AVG MIN	
Service entry points	-	Points	0,002	0,0005 AVG MIN	0,001 AVG MIN	0,0005 AVG MIN	
Water seals	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Disrepair to drains	-	Points	0,003	0,001 AVG MIN	0,001 AVG MIN	0,001 AVG MIN	
Open vent pipes	-	Points	0,002	0,0007 AVG MIN	0,0007 AVG MIN	0,0007 AVG MIN	
Design deficiencies	-	Points	0,001	0,0002 AVG MIN	0,0007 AVG MIN	0,0002 AVG MIN	
Internal refuse areas	+	Points	0,0025	0,0008 AVG MIN	0,0008 AVG MIN	0,0008 AVG MIN	
External refuse areas	+	Points	0,0025	0,0011 AVG MIN	0,0003 AVG MIN	0,0011 AVG MIN	
Refuse chutes etc.	+	Points	0,003	0,0013 AVG MIN	0,0003 AVG MIN	0,0013 AVG MIN	
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,004	0,0018	0,004	
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0092	0,01	0,0114	
Significance of the alternative				0,0152	0,0121	0,0131	
Priority of the alternative				1	3	2	
Utility degree of the alternative (%)				100%	79,65%	85,77%	

*- The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Figure 5.3. Multicriterion assessment of domestic hygiene, pests and refuse

5.3. OPERATION MANUAL FOR NATIONAL HEALTH RECOMMENDATION CERTIFICATION MODEL ADVISORY SYSTEM

Health recommendation certification system is based on the integrated experience of foreign countries and advisory system, which provides proper recommendations on living conditions enhancement in terms of answers to the questions generated by the system. The system could be launched at: <http://iti.vgtu.lt/ilearning/kapateikti.aspx> (*Figure 5.4.*).

The image shows a list of 29 questions from the Health Recommendation Advisory System. The questions are presented in a light blue background with a thin border. The questions are:

- Are there any traces of moisture or mould in your house?
- Is the temperature inside your house too low?
- Is the temperature inside your house too high?
- Are there any traces of asbestos or artificial mineral fibres in your house?
- Do you use biocides?
- Are there any sources potential to emit carbon monoxides or fuel combustion products in your house?
- Are there any sources emitting lead in your house?
- Is your house situated closely to ionising radiation sources?
- Is there any unsafe gas-fuelled equipment in your house and there is a potential for gas leakage?
- Are there any sources emitting volatile organic compounds in your house?
- Does your house have too little space (if compared to a number of people residing therein)?
- Do you consider your house to be well protected against the risk of intrusion?
- Is the lighting of your house good?
- Do you experience too high noise from surrounding external and internal noise sources inside your house?
- Is the hygiene of your living conditions not sufficient inside your house (presence of parasites, waste)?
- Are the conditions suitable for food preparation and storage in your house?
- Are the sanitary conditions favourable at your house?
- Is the water supply system of your house of good condition?
- Is there any danger of falling down in the bathroom of your house?
- Is there any danger related to flat surfaces?
- Are there any stairs installed in your house?
- Is there any danger of falling down from one level to another in your house?
- Is the electrical installation of your house of good condition?
- Is there any danger of fire in your house?
- Are there any open flame sources in your house? Are there any surfaces that heat up heavily?
- Is there any danger of injury due to unsuitable structures, location of things, etc.?
- Are there any conditions in your house potentially leading to explosion?
- Are objects and structural elements of your house arranged in a comfortable and functional manner?
- Is there any danger of collapse/falling down of structures/elements in your house?
- Ar pro Jūsų gyvenamąją vietą eina elektros linijos?
- Ar Jūsų namuose yra prietaisų ar įrenginių?

Figure 5.4. Health Recommendation Advisory System

Title page includes 29 questions. The user could select needed aspect, for example, recommendation is equipped with lighting, which could cause eye strain from glare and a lack of adequate light (natural or artificial), and the user strains after minimization of the above mentioned

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

hazard and improve safety level of its recommendation. By clicking appropriate icon the user could tick the question “Is the lighting of your house good?”. The system will generate additional questions enabling the determination of main hazard sources (e.g., shape, position and size of windows, inappropriately positioned artificial lighting, etc) (Figure 5.5.)



The screenshot shows a vertical list of three questions, each with a dropdown menu on the left. The first question is "Is natural lighting sufficient in your house?", the second is "Is artificial lighting sufficient in your house?", and the third is "Are there no light blocking objects close to the building?". Each dropdown menu currently displays "Ne" with a downward arrow.

Figure 5.5. Additional advisory questions of health recommendation system about lighting.

Upon answering to the additional questions, the user could click on “Show recommendations”. The system will evaluate answers and generate recommendations related to the improvement of lighting quality and to the means required in order to enhance safety level of lighting (Figure 5.6.).

Windows should be wide enough to provide for a reasonable view of the immediate surroundings. Sills in living areas should be low enough to allow a seated person a reasonable view. (Safety glass should be provided in vulnerable locations.) Window heads should be above the eye level of someone standing. Ideally, the views should be of open space through windows of all rooms other than those where privacy is required such as bathrooms and wc compartments. The view should also provide for supervision of outside recreation space and, for security purposes, of the means of access to the dwelling.

Source: The Office of the Deputy Prime Minister 2006. *Housing health and safety rating system: operating guidance*, Office of the Deputy Prime Minister: London, 185 p.

Insufficient natural lighting shall be compensated by the artificial one. Properly selected artificial lighting could enhance viability and strengthen level of health. Still, you should remember that long-lasting staying at a bright light is undesirable; you should go out outside for a short time and stay at a daylight.

Source: *Light and lighting* (2013) [interactive]. [see 14 July 2013]. Internet access: <<http://www.asu.lt/nm/l-projektas/rekreacijabioa/18.htm>>

Natural lighting of rooms depends on external greenery. Trees and loaches minimize flow of light. It is common for entry levels. Flow of light could also be minimized by curtains and blinds.

Source: *Light and lighting* (2013) [interactive]. [see 14 July 2013]. Internet access: <<http://www.asu.lt/nm/l-projektas/rekreacijabioa/18.htm>>

While fitting your apartment you should remember the following things: light from the northern part is much calmer, without shadows, it shall be used for longer working; from the southern part – blinds and forms shadows and is not very suitable for working; from the east – it is calm and suits for bedrooms and kitchens, moreover, it exalts spiritual feelings; from the west – it is warm, relaxing, suits for calming down before going to bed.

Source: *Light and lighting* (2013) [interactive]. [see 14 July 2013]. Internet access: <<http://www.asu.lt/nm/l-projektas/rekreacijabioa/18.htm>>

Figure 5.6. Recommendations to the user.

5.3.1. ADDING CONTENT

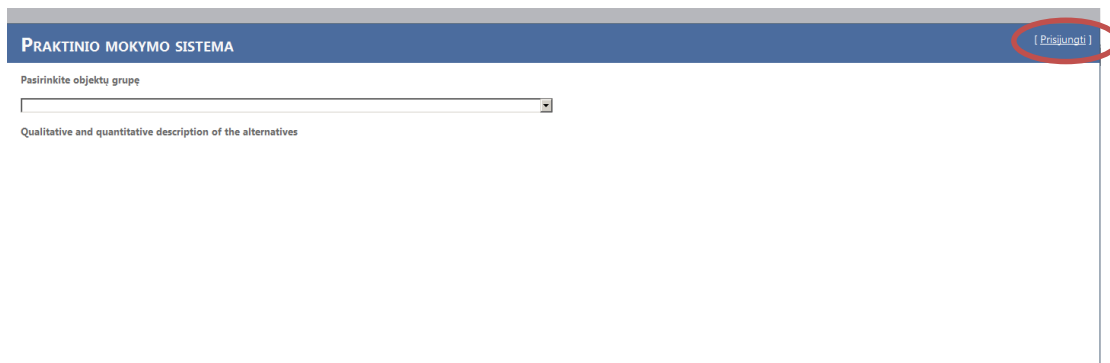
As was said before, these tools are for expert and non-expert users on construction. If you are expert, maybe you have some information that you would like to share with the rest. In the following points we can find the steps to do it.

➤ **Creating a new account**

1. Go to <http://iti2.vgtu.lt/imitacijosmain/simpleteable.aspx>
2. Click *[Log in]*.
3. Then click *Sign up*.
4. Enter the following data in the form *Account Information*:
 - a. your system login name in the field *Username*;
 - b. your e-mail address in the field *E-mail*;
 - c. your system login password in the field *Password*;
 - d. repeat your password in the field *Confirm Password* for verification.
5. Click *Create User*.

➤ **Logging in to the system**

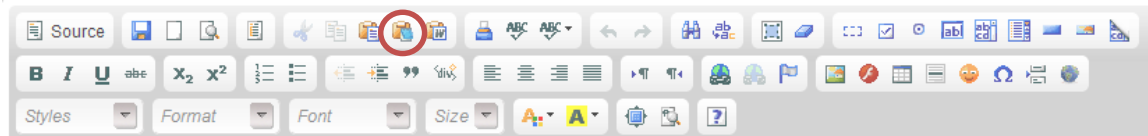
1. If you already have a username and password, go to <http://iti.vgtu.lt/imitacijosmain/Account/Login.aspx>
2. Enter your username and password and click *Log in*.



3. Click the menu option *Administration* and then *Create a New System*.
4. From the list *Choose a System*, select the type of your new system:
 - a. Computer-based practical training system for construction works of exceptional significance;
 - b. Computer-based practical training system for structural solutions of construction works of exceptional significance;
 - c. Computer-based practical training system for property developers;

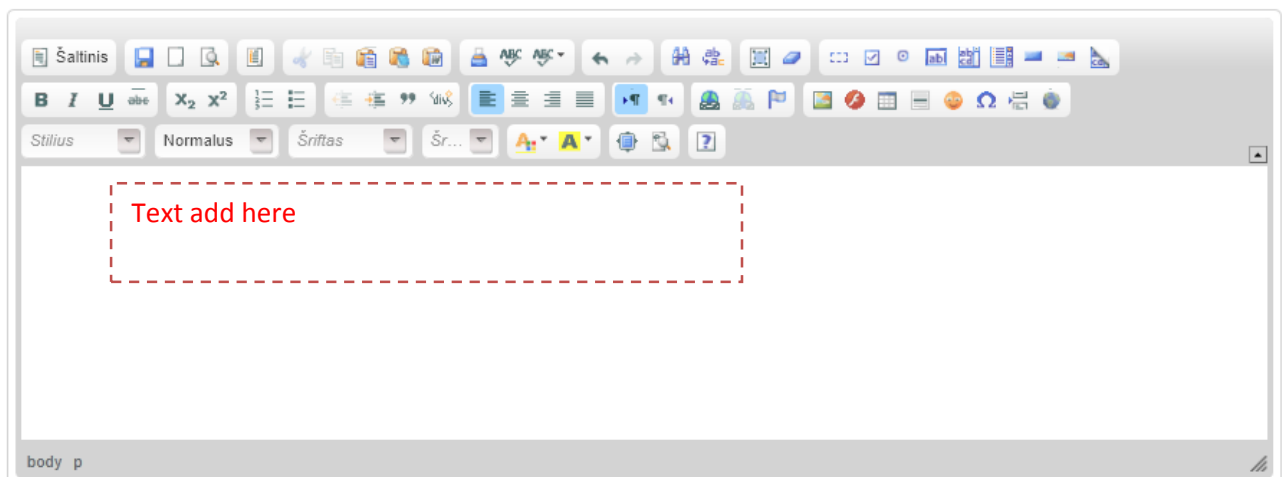
HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

- d.
5. From the list *Choose a Subsystem*, select the subsystem you need.
6. Enter the system's name in the field *New System's Name*.
7. Enter the system's name in English in the field *New System's Name, EN*.
8. In the field *New System description*, paste the text copied in advance to your clipboard:
 - a. click *Paste as Plain Text*;



- b. click on the pop-up window with your mouse and use the keyboard shortcut Ctrl+V to paste the text from your clipboard;

Description of system EN

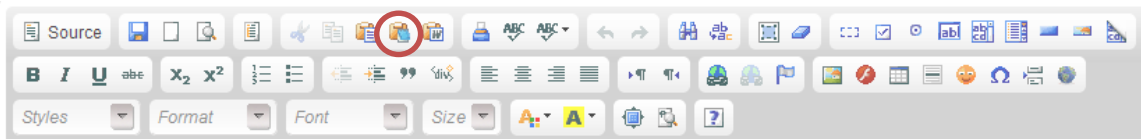


- c. follow the same procedure as in points (a) and (b) to paste your text in the field *About the new system, EN*.
9. Use the field *System Icon* to add the system's logo. The procedure is as follows:
 - a. click *Browse*;
 - b. in the pop-up window, chose any JPG, PNG or GIF image from your computer,
 - c. click *Open*.
10. Tick the option *Make Public at Once* if you want to make your new system public.
11. Once you have filled in all the fields, click *Add the System* at the bottom of the page.
12. To see whether the system has been successfully added to the lists, click the menu option *Your Systems* at the top of the page. You should see a brief description of your system in the list below this menu option.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

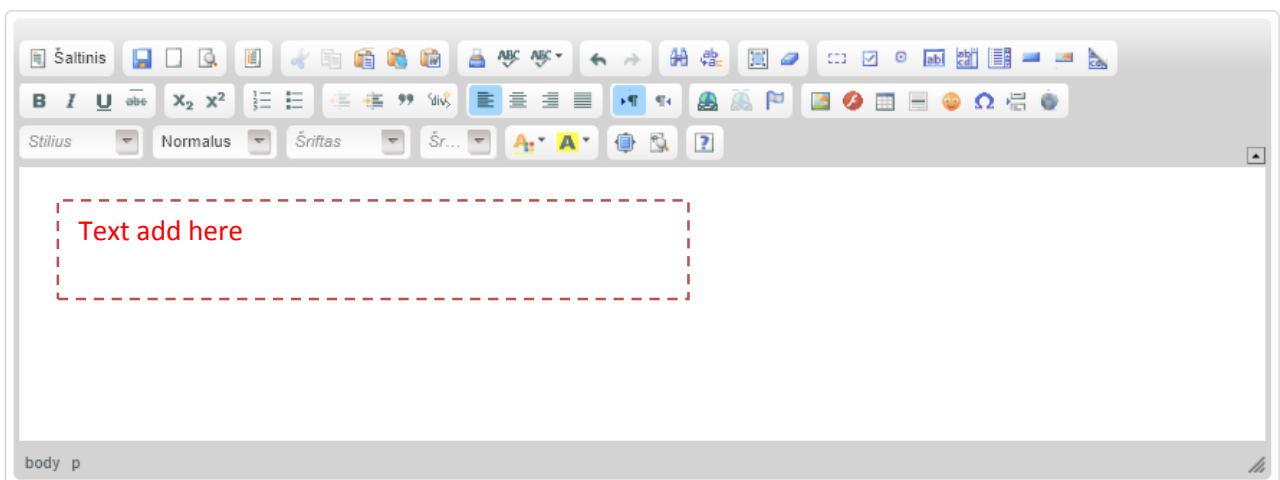
➤ Creating groups of system's objects

1. Click the menu option *Administration* and then *Groups of System's Objects*.
2. From the list *Your Systems*, select the name of your system to which you want to add groups of objects.
3. Enter the group's name in the field *Group's Name* (e.g. *Stogas*; other groups may be *Langai*, *Durys*, etc.).
4. Likewise (as in point 3), use the field *Group's Name, EN* to enter the group's name in English.
5. In the field *About the Group of Objects*, paste the text copied in advance to your clipboard:
 - a. click *Paste as Plain Text*;



- b. click on the pop-up window with your mouse and use the keyboard shortcut **Ctrl+V** to paste the text from your clipboard.
 - c. follow the same procedure as in points (a) and (b) to add your text to the field *About the group of objects, EN*.
6. Once all the fields have been filled in, click *Add the Group*.

Description of system EN

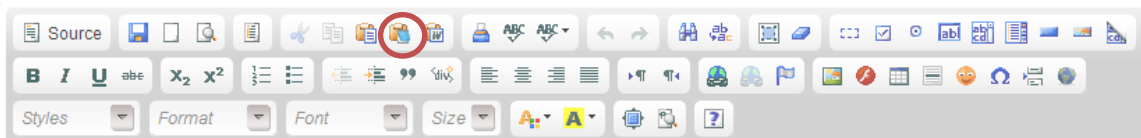


➤ System's objects (alternatives)

1. Click the menu option *Administration* and then *Systems' Objects*.

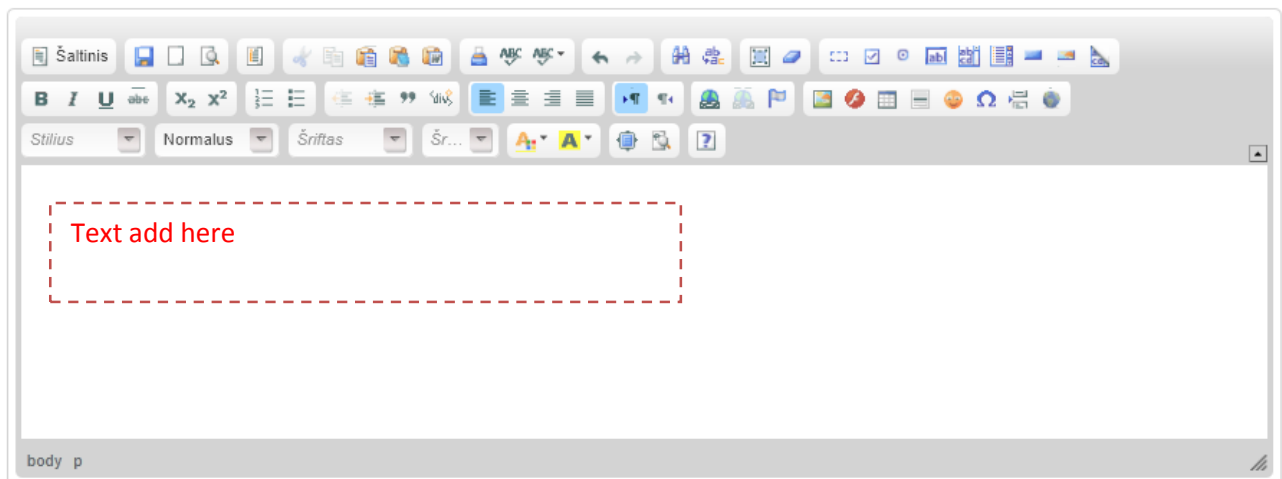
HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

- From the list *Your Systems*, select the name of your system to which you want to add alternatives.
- From the list *Groups of System's Objects*, select the group of objects to which you want to add alternatives.
- Enter a short name of the alternative in the field *Object's Name*.
- Enter a short name of the alternative in English in the field *Object's Name, EN*.
- In the field *About the Object*, paste the text copied in advance to the clipboard:
 - click *Paste as Plain Text*;



- click on the pop-up window with your mouse and use the keyboard shortcut Ctrl+V to paste the text from your clipboard;
 - follow the same procedure as in points (a) and (b) to add your text to the field *About the object, EN*.
- Once all the fields have been filled in, click *Add the Object*.

Description of system EN

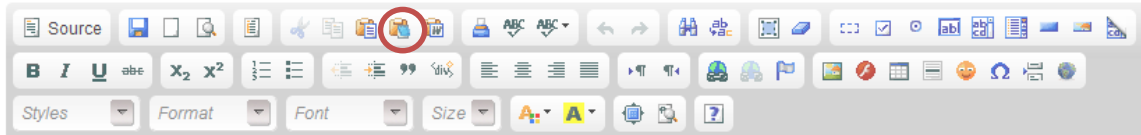


➤ System criteria

- Click the menu option *Administration* and then *System Criteria*.
- From the list *Your Systems*, select the name of your system to which you want to add alternatives.
- From the list *Groups of System's Objects*, select the group of objects to which you want to add criteria.
- Enter the name of your criterion in the field *Criterion's Name*.

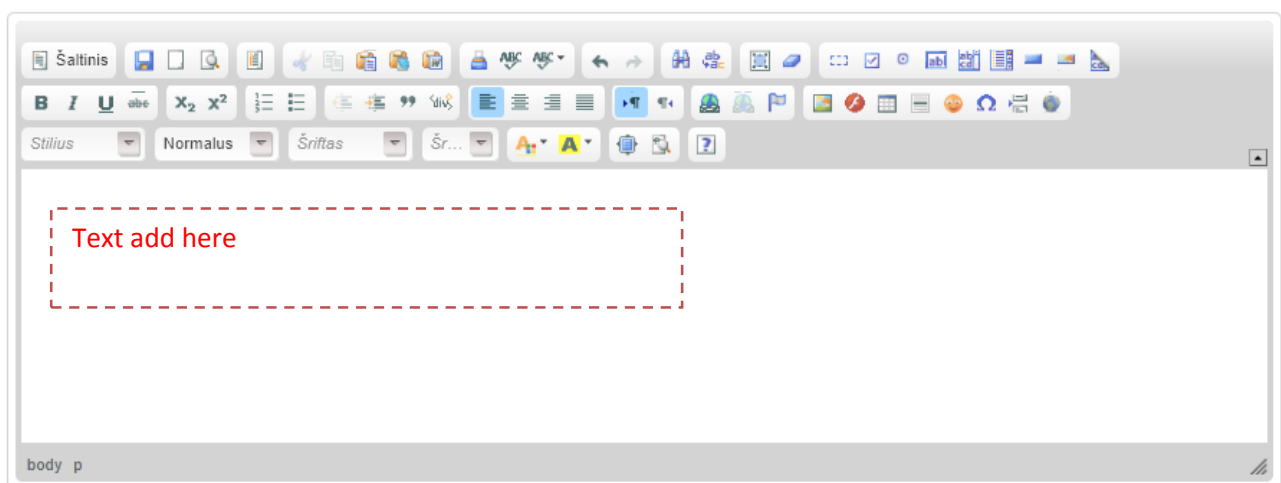
HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

5. Enter the name of your criterion in English in the field *Criterion's Name, EN*.
6. In the field *About the Criterion*, paste the text copied in advance to the clipboard:
 - a. click *Paste as Plain Text*;



- b. click on the pop-up window with your mouse and use the keyboard shortcut Ctrl+V to paste the text from your clipboard;

Description of system EN



- c. follow the same procedure as in points (a) and (b) to add your text to the field *About the Criterion, EN*.
7. Tick the option *Maximising Criterion* if the criterion is maximising (+); if the criterion is minimising (-), leave the option unticked.
8. Enter the criterion's weight (e.g., 0.089) in the field *Criterion's Weight*.
9. Select the measuring unit for this criterion (e.g., '000 LTL, points, etc.) from the list *Criterion's Measuring Unit*.
 - a. If you don't see the required measuring unit in the list:
 - i. click the menu option *Administration* and then *Measuring Units*;
 - ii. enter the measuring units you need in the field *Name* (the units will be added to the list specified in Point 9 above);
 - iii. click *Add*.
10. Click *Add*.

➤ System's parameters

1. Click the menu option *Administration* and then *System's Parameters*.

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

2. From the list *Your Systems*, select the name of your system to which you want to add alternatives.
3. From the list *Groups of System's Objects*, select the group of objects to which you want to add criteria.
4. Select the alternative from the list *Group's Objects*.
5. From the list *Group's Criteria*, select the criterion (e.g., *RE offer price*) the value of which you want to enter (change the parameter).
6. Enter the value (e.g., 247.2) in the field *Parameter* and click *Update*.
 - a. To add values for all criteria of one alternative at once, use the quick update field between the buttons *Update* and *Quick Update*.

Your systems:

Energy efficient house in Africa

Object group of system

Glazing

Objects of the group objects

Glazing 1 (neutral)

Criteria of the object group of the system

Glazing U value

Parameter

3

Update

Quick add field, example:

124.0
126.7
125.4
12.12
126.0

Fast multiple values input

System check

- b. Enter the data in a column (you may also paste your data—use Ctrl+V).

- c. Then click *Quick Update*.
7. Likewise, enter the values for any other alternatives selected from the list *Group's Objects*.

To end your session, click [*Logout*] at the top-right corner.

CHAPTER VI: Conclusions

After developing this paper according to the research methodology presented at the beginning of it, and having made a general analysis, we have come to the following conclusions.

Every day we are exposed to large risks at home, we are not aware of, and which are the reason of some of the health problems that we suffer. Since we spend lot of time at home, it is important, therefore, that we keep our home the “healthiest” we can.

Some of these risks could be easily identified by the users, non-expert people, whereas to the rest, we could need professional aid.

In this paper we have done a complete analysis of the problems of lighting, noise, electrical hazard and domestic hygiene, pests and refuse, in which we can observe how they can affect our health and which could be their causes. These are the most common problems that we can find day-to-day in our dwelling. It is very common, for example, to have an inadequate artificial light, which could cause headache or eye strain, or excess of noise from the outside because of poor sound proofing, causing psychological disturbances and physiological changes.

As mentioned before, these problems can be identified by the users of dwellings. We have suggested the idea of integrating augmented reality and decision support systems, with the interactive tool “Virtual House Intelligent System”. In order to help these people to recognize the hazards that they are exposed to, considering that the user could perceive with pictures as examples, how they could appear in their home. And with an external link, they could make a questionnaire, after which they will receive some recommendations to follow to decrease or eliminate health problems.

To conclude, the results, which can be obtained after this paper, are to eliminate the problems we found in our dwelling related to lighting, noise, electrical hazard and domestic hygiene, reducing disease causing their inhabitants.

Design of buildings will be improved, taking into account the damage and exposure to which users will be submitted subsequently, besides the necessary information for good use and home maintenance will be given, thus improving their quality of life.

This paper will be valued to the construction industry, because it will improve quality in the sector. In addition, it will also be useful for non-expert users, and even for medical staff, because since we will know where we should pay special care and attention, and where we could find the source of some diseases.

APPENDIX I

LIGHTING RECOMMENDATION

- a) ES: Cuando esté equipando tu apartamento debería recordar las siguientes cosas: la luz que proviene del norte es mucho más tranquila, sin sombras, que se utilizará para un trabajo más prolongado; la proveniente del sur - ciega y crea sombras y no es muy adecuada para trabajar; la del este - es tranquila y adecuada para dormitorios y cocinas, además, exalta los sentimientos espirituales; la del oeste - es cálida y relajante, adecuada para calmarse antes de ir a dormir.
- RO: Când îți echipezi apartamentul ar trebui să-ți amintești de următoarele lucruri: lumina ce vine din partea de nord este mai liniștitoare, fără umbre, și se utilizează pentru lucru îndelungat; cea care provine din sud- este orbitoate și formează umbre, și nu este adecvată pentru a lucra; cea din est- este liniștitoare, adecvată pentru dormitoare și bucătării, în plus, exaltează trăiri spirituale; cea din vest- este caldă, relaxantă, potrivită pentru a ne calma înainte de a dormi.
- b) ES: La luz natural en las habitaciones depende de la vegetación exterior. Los árboles y arbustos minimizan el flujo de la luz. Es común en los niveles de entrada. El flujo de luz también puede ser minimizado por cortinas y persianas
- RO: Lumina naturală din camere depinde de vegetația din exterior. Arborii și arbuștii minimizează fluxul de lumină. Este normal pentru nivelurile de intrare. Fluxul de lumina poate fi minimizat și de perdele sau obloane.
- c) ES: La insuficiencia de luz natural será compensada con luz artificial. Una iluminación artificial adecuadamente seleccionada podría mejorar la viabilidad y fortalecer el nivel de salud. Sin embargo, debería tener presente que una larga exposición ante este tipo de luz es molesta; así que debería salir al exterior durante las horas de luz solar.
- RO: Insuficientă luminii naturale va fi recompensată de prezența luminii artificiale. O iluminare artificială adecvată poate îmbunătăți viabilitatea și rezistența nivelului de sănătate. Totuși, expunerea îndelungată la acest tip de lumină poate deranja; așa că ar trebui ieșit puțin afară pe durata zilei.
- d) ES: La intensidad de la luz depende del tipo de trabajo. Escribir y leer requieren una intensidad sobre unos 300 lx, la iluminación general de una habitación 50-75 lx, en cocinas sobre 100 lx, y en habitaciones auxiliares 20-50 lx. Una iluminación más intensa podría asegurarse con aparatos locales usados en las zonas de trabajo. No olvide aunar la intensidad de la iluminación local con la iluminación de toda la habitación. Esto lo protegerá de la fatiga ocular e incrementará la eficiencia en el trabajo.

RO: Intensitatea luminii depinde de tipul de muncă. Citirea și scrierea necesită o intensitate a luminii aproximativ de 300 lx, iluminarea generală a unei camere de 50-75 lx, în bucătăriei aproximativ 100 lx și în camere auxiliare 20-50 lx. O iluminare mai intensă se poate asigura cu aparate locale utilizate în zona de lucru. Nu uitați să ajustați intensitatea luminii locale cu cea a luminii în întreaga cameră. Acest lucru va proteja ochii dumneavoastră de epuizare și va crește productivitatea muncii.

- e) ES: Rellanos, peldaños y escaleras deberán estar suficientemente iluminados con un flujo de iluminación uniformemente distribuida. Los peldaños deberán ser visibles; las lámparas no deben interrumpir el movimiento ni engancharse en la ropa.

RO: Holurile, treptele și scările ar trebui să fie suficient luminate cu un flux de lumină uniform distribuit. Treptele ar trebui să fie vizibile; lămpile nu trebuie să întrerupă mișcarea, nici să se aghete de haine.

- f) ES: Se prestará una atención adicional a la iluminación de la cocina. La preparación de alimentos se llevará a cabo en condiciones de buena iluminación con el fin de evitar lesiones, cortes, pinchazos. En general, las cocinas están equipadas con una lámpara central, manteniendo la luz de fondo. La iluminación local deberá ser instalada por debajo de los aparadores. Se recomienda equipar las lámparas anteriormente mencionadas con interruptores individuales, pudiendo ser usadas sólo cuando sea necesario. La lámpara instalada en la campana de recogida de vapores de la cocina emitirá suficiente cantidad de luz. La misma iluminación local se utilizará encima del fregadero.

RO: Se va acorda atenție în plus la iluminarea bucătăriei. Prepararea alimentelor se va face cu o bună iluminare pentru a evita leziuni, tăieturi sau înțepături. În general, bucătăriile sunt echipate cu o lampă centrală, menținând lumina de fundal. Iluminarea locală trebuie să fie instalată sub aparate. Se recomandă echiparea lămpilor anterior menționate cu întrerupătoare individuale, putând fi utilizate doar atunci când este necesar. Lampa instalată în hota pentru captarea vaporilor va emite suficientă lumina. Aceeași iluminare locală se va utiliza deasupra chiuvetei.

- g) ES: El cuarto de baño estará equipado con una lámpara general instalada en el techo, la cual iluminará todo el área del cuarto de baño. Se usará una lámpara de tipo cerrado, protegiendo así del vapor y la acumulación de humedad. Podría ser instalada una iluminación local por encima del espejo.

RO: Baia va fi echipată cu o lampă generală instalată în tavan, ce va ilumina toate suprafețele din baie. Se va utiliza o lampă închisă, fiind protejată de vapori și de acumularea de umezeală. Ar putea fi instalată o iluminare locală deasupra oglinzii.

- h) ES: La iluminación en la sala de estar y comedor podría ser seleccionada individualmente dependiendo de la finalidad y las funciones de la sala en particular. Algunos de los aspectos generales de esta iluminación son: la iluminación general podría ser más brillante o calmada dependiendo del ambiente, algunas áreas de la habitación en particular podrían ser equipadas con lámparas en soportes o lámparas de pie. La mesa del comedor deberá estar suficientemente iluminada.

RO: Iluminarea în sala de așteptare și în sufragerie se va alege individual depinzând de finalitatea acțiunilor și de funcțiunile sălii în general. Unele dintre aspectele generale ale iluminării sunt: iluminarea generală poate fi mai strălucitoare sau mai calmă depinzând de ambient, anumite suprafețe ale încăperii în particular ar putea fi echipate cu lampa cu suport sau cu lampa cu picior. Masa din sufragerie trebuie să fie suficient iluminată.

- i) ES: La iluminación en el dormitorio será tenue, proporcionada por una lámpara general; adicionalmente podrían usarse lámparas locales de noche para leer y vestirse. La lámpara de noche iluminará el libro y no perturbará el sueño de la persona que esté junto a ti.

RO: Iluminarea din dormitor trebuie să fie slabă, proporționată de o lampă generală; adițional se pot utiliza lămpi locale de noapte pentru a citi sau îmbrăca. Lampa de noapte va ilumina cartea și nu va perturba somnul persoanei care este alături de tine.

- j) ES: La intensidad de la iluminación de la habitación de un niño debe ser mayor en comparación con la iluminación de la habitación de los padres. Para este propósito se podrían utilizar lámparas locales para juegos o tareas.

RO: Intensitatea luminii camerei unui bebeluș trebuie să fie mai mare în comparație cu cea a camerei părinților. În acest scop se pot utiliza lămpi locale pentru jocuri sau sarcini.

- k) ES: El diseño de la vivienda, en particular de las salas de estar y cocinas, y espacios de recreación, deben permitir la entrada de luz solar. Deberá haber suficiente luz natural durante el día, permitiendo que se lleven a cabo las tareas domésticas sin fatiga visual. Las ventanas deben tener un tamaño adecuado, y una forma y posición adecuada permitiendo una razonable entrada de luz natural en las habitaciones. Sótanos y habitaciones en plantas bajo el sub-suelo pueden plantear problemas particulares, y deberá haber un adecuado y suficiente espacio abierto en el exterior de la ventana que permita la adecuada entrada de luz.

RO: Proiectarea locuinței, în particular a livingului sau a bucătăriei, a spațiilor de recreare, trebuie să permită intrarea luminii solare. Trebuie să existe suficientă lumină naturală pe durata zilei, permițând ducerea la sfârșit a activităților casnice fără epuizarea ochilor. Ferestrele trebuie să aibă dimensiuni adecvate, o formă și o poziție potrivite, permițând o intrare rezonabilă a luminii naturale în încăperi. Beciurile și încăperile de la subsol pot pune probleme particulare și trebuie să aibă un spațiu adecvat și deschis suficient la exteriorul ferestrei ce poate permite penetrarea luminei.

- l) ES: La iluminación artificial se debe colocar para proporcionar suficiente luz para llevar a cabo las actividades domésticas y recreativas, sin causar fatiga visual ni crear reflejos o sombras. La luz artificial es particularmente importante donde las tareas domésticas requieran suficiente luz, por ejemplo en la encimera de la cocina, lavabos y fogones.

RO: Iluminatul artificial trebuie să fie poziționat pentru a oferi lumină suficientă pentru desfășurarea activităților casnice și de agrement și pentru ca acestea să fie efectuate fără oboseala ochilor și fără a crea strălucire sau umbre. Lumina artificială este deosebit de importantă în cazul în care sarcinile domestice au nevoie de lumină adecvată, de exemplu, în bucătărie, peste mese de lucru, chiuvete și mașini de gătit.

- m) ES: Las ventanas deben ser lo suficientemente amplias para una vista razonable del entorno inmediato. El alféizar en las zonas de salas de estar debe ser lo suficientemente bajo como para permitir a una persona sentada una vista razonable. (Se proveerán con vidrios de seguridad en zonas vulnerables). La parte superior de la ventana debe estar por encima del nivel de los ojos de una persona de pie. Lo ideal es que las vistas a través de las ventanas, sean a un espacio abierto en todas las habitaciones, salvo en aquellas donde se requiere privacidad, como en baños y aseos. La vista también debe permitir la supervisión del espacio recreativo exterior, y por motivos de seguridad, de los medios de acceso a la vivienda.

RO: Ferestrele trebuie să fie ample suficient pentru o vedere rezonabilă în împrejurimile imediate. Pervazurile din livinguei trebuie să fie suficient de joase ca să permită unei persoane așezate o vedere rezonabilă. (Se prevăd ferestre de siguranță în zone vulnerabile). La partea superioară a ferestrei trebuie să fie deasupra nivelului ochilor al unei persoane care stă în picioare. Ideal ar fi că vederile prin fereastră să fie un spațiu deschis în toate încăperile, cu excepția acelor ce au nevoie de intimitate, cum ar fi băi, wc-uri. Vederea trebuie de asemenea să permită supravegherea spațiului recreativ exterior, și pentru motive de securitate, al mediului de acces în locuință.

- n) ES: Evitar la ausencia total de luz natural, aun con una adecuada luz artificial, debido a la sensación de encerramiento que esto supone.
RO: Evitați absența totată a luminii naturale, chiar și cu o lumină artificială adecvată, datorită senzației se închidere pe care o supone.
- o) ES: Distribuir uniformemente los niveles de iluminación. La desigual distribución de las lámparas produce diferencias de intensidad luminosa.
RO: Distribuți normal nivelurile de iluminare. O distribuire inegală a lămpilor produce diferențe de intensitate de lumină.
- p) ES: Evitar el deslumbramiento, controlando todas las fuentes luminosas existentes dentro del campo visual. Utilizando persianas o cortinas en las ventanas, así como el empleo de luminarias con difusores o pantallas que impidan la visión del cuerpo brillante de las lámparas.
RO: Evitați strălucirea, controlați sursele de iluminare existente în interiorul câmpului vizual. Utilizând jaluzele sau cortine la ferestre, la fel și lămpi cu lumina dispersată sau ecrane ce impun vizualizarea corpului strălucitor al lampei.
- q) ES: Sobre los colores del lugar de trabajo, adecuarlos a la hora de decorar los locales: un uso inapropiado de los colores puede contribuir a hacer más acusados los contrastes.
RO: Despre culorile luminii la locul de muncă, adaptatele atunci când decorați camera: o culoare nepotrivită poate sublinia un contrast pronunțat.
- r) ES: Escaleras y rellanos deben tener una buena iluminación general por seguridad. Para prevenir accidentes, las escaleras deben estar iluminadas de arriba abajo, con interruptores en ambos lugares. Para la seguridad en los pasillos, se debe colocar iluminación cada 8 o 10 pasos.
RO: Scările și holurile trebuie să aibă o bună iluminare pentru securitate. Pentru a preveni accidente, scările trebuie să fie iluminate de sus în jos, cu întrerupătoare în ambele locuri. Pentru siguranța holului, trebuie prevăzută iluminare la fiecare 8 sau 10 pași.

NOISE RECOMMENDATION

- a) ES: Para evitar los problemas de tráfico y otros ruidos del exterior, el nivel de aislamiento debe ser adecuado a los niveles de ruido ambiental. Cuando los niveles de ruido son altos, es necesario un doble acristalamiento, o un secundario, y vestíbulos en puertas exteriores. Un triple acristalamiento puede ser necesario cerca de aeropuertos u otras fuentes de altos niveles de ruido. El aislamiento en el techo de la planta superior y cubierta será importante donde se prevea ruido de aviones. Aunque, en aquellos lugares en los que se dispone de un doble o triple

acristalamiento para proteger a los ocupantes del ruido, se debe disponer de una adecuada alternativa para la ventilación.

RO: Pentru a preveni problemele de trafic și alte zgomote exterioare, nivelul de izolare trebuie să fie adecvat la nivelurile de zgomot ambiental. În cazul în care nivelurile de zgomot sunt ridicate, pot fi necesare: geamuri duble sau secundare, holuri înspre ușile exterioare. Poate fi necesar geam triplu în apropierea aeroporturilor sau de alte surse de niveluri foarte ridicate de zgomot. Izolarea plafonului de la etaj și a acoperișului va fi importantă în cazul în care exista zgomot de la aeronave. Cu toate acestea, în cazul în care este furnizat geam dublu sau triplu pentru a proteja ocupații de zgomot, trebuie să existe prevederi alternative adecvate pentru ventilare.

- b) ES: El ruido de las tuberías, incluido el de inodoros y cisternas, pueden ser reducidos ubicándolos separados de los muros. La ubicación de los cuartos de baño y aseos en los pisos no debe ser sobre salas de estar o dormitorios. La separación entre muros y plantas, especialmente en pisos y dúplex, deben ser construidas adecuadamente para reducir el impacto y la transmisión del sonido en el aire.

RO: Sunetul conductelor , inclusiv cel al toaletei și cisternei pot fi reduce prin plasarea lor departe de pereți . Amplasarea de băi și grupuri sanitare la etaj, nu ar trebui să fie înspre camere de zi sau dormitoare. Separațiile dintre pereți și pardoseli, mai ales în case și duplexuri , ar trebui să fie construite în mod corespunzător pentru a reduce impactul și transmiterea sunetului în aer.

- c) ES: Aislamiento acústico a ruido aéreo: Los elementos constructivos interiores de separación, así como las fachadas, las cubiertas, las medianerías y los suelos en contacto con el aire exterior que conforman cada recinto de un edificio deben tener, en conjunción con los elementos constructivos adyacentes, unas características tales que se cumpla: protección al ruido generado en recintos pertenecientes a la misma unidad de uso en edificios de uso residencial privado; protección frente al ruido generado en recintos no pertenecientes a la misma unidad de uso; protección frente al ruido generado en recintos de instalaciones y en recintos de actividad; protección frente al ruido procedente del exterior.

RO: Izolare fonică împotriva zgomotului aerian: Compartimentările interioare , fațadele , acoperișul, pereții de compartimentare și pardoselile în contact cu aerul exterior într-o clădire trebuie să aibă , în conformitate cu părțile structurale adiacente , astfel de caracteristici cum ar fi : protecția împotriva zgomotului generat în zone care fac parte din aceeași unitate de folosință în clădiri pentru uz rezidențial privat , protecție împotriva zgomotului generat în zone care nu

fac parte din aceeași unitate , protecție împotriva zgomotului generat în zonele de instalații și în zonele de activitate , protecție împotriva zgomotului provenind din exterior .

- d) ES: Aislamiento acústico a ruido de impactos: Los elementos constructivos de separación horizontales deben tener, en conjunción con los elementos constructivos adyacentes, unas características tales que se cumpla: protección frente al ruido generado en recintos no pertenecientes a la misma unidad de uso; protección frente al ruido generado en recintos de instalaciones o en recintos de actividad.

RO: Efecte de zgomot acustic: Părțile orizontale , în conformitate cu componentele adiacente , au următoarele caracteristici: protecție împotriva zgomotului generat în zone care nu aparțin aceleiași unități de utilizare , protecție împotriva zgomotului generat în zone de instalații sau domenii de activitate.

- e) ES: Se limitarán los niveles de ruido y de vibraciones que las instalaciones puedan transmitir a través de las sujeciones o puntos de contacto de aquellas con los elementos constructivos, de tal forma que no se aumenten perceptiblemente los niveles debidos a otras fuentes de ruido.

RO: Se limitează nivelurile de zgomot și vibrațiile pe care instalațiile le pot emite prin intermediul elementelor de fixare sau prin cele ce intra în contact cu alte elemente, astfel încât nivelul zgomotului ce vine dintr-o altă sursă să nu crească semnificativ.

- f) ES: El nivel de potencia acústica máximo de los equipos generadores de ruido estacionario (como los quemadores, las calderas, las bombas de impulsión, la maquinaria de los ascensores, los compresores, grupos electrógenos, extractores, etc) situados en recintos de instalaciones, así como las rejillas y difusores terminales de instalaciones de aire acondicionado, será tal que se cumplan los niveles de inmisión.

RO: Nivelul maxim de putere acustică a echipamentelor generatoare de zgomot(cum ar fi arzătoare , cazane , pompe cu rotor, ascensoare, compresoare, generatoare, ventilatoare de evacuare , etc) situate în carcusele instalațiilor și grilaje și dispersarea sistemelor de aer condiționat trebuie să fie astfel încât nivelurile de emisie sunt respectate .

- g) ES: Utilizar materiales de construcción que contribuyan a la protección frente al ruido con adecuadas propiedades acústicas.

RO: Folosiți materiale de construcție care contribuie la protecția împotriva zgomotului, cu proprietăți acustice corespunzătoare.

- h) ES: La fijación de los cercos de las carpinterías que forman los huecos (puertas y ventanas) y lucernarios, así como la fijación de las cajas de persiana, debe realizarse de tal manera que quede garantizada la estanquidad a la permeabilidad del aire.

RO: Fixarea tâmplăriei la uși și ferestre și a luminatoarelor, precum și fixarea obloanelor trebuie să fie astfel încât să se asigure etanșeitarea aerului.

DOMESTIC HYGIENE, PESTS AND REFUSE RECOMMENDATIONS

a) ES: El rodapié no es solo bueno escondiendo irregularidades en muros y suelos, sino que también impide la entrada de suciedad por debajo y mientras limpiamos protege los muros de las manchas. Este perfil está diseñado específicamente para ocultar el cableado eléctrico, de teléfono, de televisión o de Internet bajo ello.

RO: Plintele, nu numai că ascund frumos neregulile din pereți și podea, dar nu lăsa murdăria sapatrunda mai adânc și în timpul curățeniei protejează pereții de pete. Profilul este proiectat special pentru a ascunde cablurile electrice, de telefon, televizor sau internet sub ea.

b) ES: En el mercado existe una gran variedad de rodapiés, por lo que a la hora de elegirlo, es recomendable tener en cuenta sus características, del material del que está hecho, y la importancia para el interior. Ahora la mayoría de los arquitrabes vendidos son de plástico moldeado por soplado. Son ligeros, flexibles y durables no solo ante la humedad, sino también ante daños mecánicos. Podrían romperse con un golpe fuerte, que la madera natural no aguantaría tampoco. La ventaja de los rodapiés de plástico sobre los de madera es que éstos no sufren ninguna deformación cuando se humedecen, ni cuando se secan, y tampoco su color cambia por el sol.

RO: Pe piața exista o varietate de plinte placi, așa că atunci când alegeți, este recomandabil să se ia în considerare caracteristicile sale, materialele din care sunt făcute, relevant la interior. Acum, cea mai mare parte a arhitravelor vândute, sunt cele turnate din plastic umflat. Ele sunt ușoare, flexibile, durabile, nu numai pentru umiditate, dar, de asemenea, și pentru daune mecanice. Ele ar putea fi sparte cu o lovitură puternică, dar care nici cea din lemn natural nu o va suporta. Avantajele plintelor de plastic spre deosebire de cele de lemn este că nu vor suferi nici o deformare nici atunci când se umezesc, nici atunci când se usucă, de asemenea, culoarea lor nu se va schimba de la soare.

c) ES: El diseño, la construcción y el posterior mantenimiento de la vivienda deberían permitir que se mantenga limpio, evitando la acumulación de suciedad y polvo que permite a los organismos multiplicarse. Las áreas de la vivienda destinadas a la higiene personal, las instalaciones sanitarias o para el almacenamiento de alimentos, preparación y cocina deberían ser aptos para mantenerse en buenas condiciones higiénicas.

RO: Proiectarea, construirea și întreținerea ulterioară a locuinței ar trebui să permită să fie păstrată curată, prevenind acumularea de murdărie și de praf care pot permite multiplicarea organismelor. Zone ale locuinței destinate spălării personale, salubritate sau pentru depozitarea alimentelor, prepararea și gătitul lor trebuie să poată fi menținute în stare de igienă.

- d) ES: Las paredes y techos deben ser lisos y uniformes para que puedan ser limpiados y decorados fácilmente. Deben estar libre de grietas, ya que podrían proporcionar el refugio de plagas de insectos. El suelo debe ser liso y uniforme, para poder mantenerlos fácilmente limpios. Todas las superficies deben ser lisas, uniformes y libres de grietas y fisuras que puedan permitir la entrada de, o refugiar, plagas. Las juntas entre muros y suelos, y entre muros y puertas y ventanas deben estar eficazmente selladas. Siempre que sea posible los materiales deben ser resistentes al ataque de plagas, incluidos los ataques por roedores.

RO: Pereții și tavanul ar trebui să fie netezi și uniformi pentru a permite ușoară curățare a lor și decorare. Pereții și tavanul ar trebui să nu aibă fisuri care ar putea oferi refugiu insectelor. Podelele trebuie să fie netede pentru a putea fi ușor curățate. Toate suprafețele interioare trebuie să fie netede, fără crăpături și fisuri care ar putea permite intrarea și refugiul dăunători. Rosturile dintre pereți și pardoseli, precum și între pereții, uși și ferestre trebuie să fie sigilate în mod eficient. Oriunde este posibil materialele ar trebui să fie rezistente la atacul de dăunători, inclusiv la atacul de roedere.

- e) ES: El exterior de la vivienda debe estar libre de grietas y agujeros desprotegidos. Donde sean necesarias aperturas en muros o techos, deberán ser protegidos mediante rejillas u otros métodos.

RO: Exteriorul locuinței trebuie să fie lipsit de crăpături și găuri neprotejate. În cazul în care sunt necesare deschideri ale pereților sau acoperișului, ar trebui să fie folosite grilaje sau alte metode pentru a proteja acestea.

- f) ES: Cualquier espacio dentro de la vivienda, tales como conductos de servicio, tejados y espacios bajo suelo, deben ser eficazmente sellados, aislando de las zonas de estar. Deberá haber un medio de acceso a estos espacios para el tratamiento en caso de alguna invasión. Generalmente, las viviendas deberán estar diseñadas y construidas de manera que se reduzcan, en la medida de lo posible, los espacios o huecos inaccesibles para los ocupantes de la vivienda, los cuales podrían proporcionar refugio a plagas. La ubicación de accesorios tales como depósitos de agua caliente y calderas.

RO: Orice spațiu în casă, cum ar fi conductele de servicii, acoperiș și podele trebuie să fie sigilate în mod eficient fata de zonele de locuit. Trebuie să existe un mijloc de acces la aceste

zone pentru tratament în caz de invazie. În general, locuințele trebuie să fie proiectate și construite în așa fel încât să reducă, pe cât posibil, spații goale inaccesibile locuitorilor și care ar putea oferi adăpost pentru dăunători. O atenție deosebită trebuie sata amplasării garniturilor, cum ar fi rezervoare de apă caldă și cazane.

- g) ES: El diseño y construcción deberían reducir, en la medida de lo posible, cualquier medio de acceso de plagas desde el exterior al interior de la vivienda. Todas las aberturas de desagües deben ser selladas con una eficaz junta para el agua; lo que incluye aperturas en la cuenca de desagüe del wc y drenajes de aguas residuales y superficiales. Para evitar la entrada de ratones no debe haber agujeros o huecos de más de 6,25mm. Las tomas de entrada de servicios deben ser selladas de manera efectiva, al igual que todos los puntos en muros penetrados por desechos, drenajes u otro tipo de tubos o cables. No deberá haber agujeros en el techo de la cubierta, aleros y bordes, que puedan permitir el acceso a la cubierta de ratas, ratones, ardillas o aves. Todos los orificios necesarios para la ventilación deben ser protegidos con rejillas.

RO: Proiectarea și construcția ar trebui să reducă, pe cât posibil, orice mijloace de acces ale dăunătorilor din exterior în locuință. Toate deschiderile în sistemul de canalizare ar trebui să fie sigilate cu un eficient sigiliu de apă, aceasta include: deschiderea bazinului de toaletă și drenarea apelor reziduale și a celor de exterior. Pentru a preveni intrarea șoarecilor nu trebuie să existe găuri sau lacune mai mari de 6.25 mm. Punctele de intrare la servicii trebuie efectiv sigilate la fel ca și orice punct în pereții penetrați de deșeuri, scurgeri, alte conducte sau cabluri. Nu trebuie să existe găuri în acoperiș, streasini și atice care ar putea permite accesul șoarecilor, șobolanilor, veverițelor sau păsărilor, Toate orificiile destinate ventilației trebuie acoperite cu grătare.

- h) ES: Deberá haber un suministro adecuado y suficiente para el almacenamiento de residuos en espera de recogida o tratamiento en el exterior de la vivienda. Deberá haber también un suministro adecuado y suficiente para el almacenamiento de la basura doméstica dentro de la vivienda. Deben ser fácilmente accesibles a los ocupantes, pero situados a fin de no crear un peligro para los niños. Los depósitos de basura no deben causar problemas de higiene, ni atraer ni permitir el acceso de plagas.

RO: Ar trebui să fie adecvate și suficiente provizii pentru depozitarea deșeurilor înaintea colectării sau depozitarea în afara locuinței. Ar trebui să existe, de asemenea, un adecvat și suficient spațiu pentru depozitarea deșeurilor menajere înăuntrul locuinței Ar trebui să fie ușor accesibile pentru ocupanți, dar amplasate astfel încât să nu creeze un pericol pentru copii.

Coșurile de gunoi nu ar trebui să provoace probleme de sănătate, sau de a atrage sau a permite accesul dăunătorilor.

- i) ES: En casas, bungalows y en bloques de viviendas plurifamiliares, debe haber una zona claramente definida para los contenedores de basura. Lo mejor sería al aire libre, y lejos de ventanas y ventiladores, y si es posible, a la sombra o bajo refugio.

RO: Pentru case, bungalouri și case transformate în apartamente autonome, ar trebui să existe o zonă clar definită pentru containere de gunoi. Acest lucru este cel mai bine în aer liber, și departe de ferestre și ventilatoare, și, dacă este posibil, în umbră sau într-un adăpost

- j) ES: Para los edificios de viviendas de no más de cuatro plantas, la disposición de basura puede ser mediante el uso de conductos, o mediante contenedores de almacenamiento de residuos con libre ventilación. Para edificios de viviendas de más de cuatro plantas, se recomiendan conductos comunes (a menos que se instalen equipos de combustibles sólidos). Los conductos deben descargar en almacenes con grandes contenedores. Cualquier almacén debe estar diseñado, construido y mantenido para reducir, en la medida de lo posible, la invasión de plagas. Deberán estar también situados, diseñados, construidos y mantenidos de manera que no permitan la entrada de aire del almacén en cualquier sala de estar.

RO: În blocuri de locuințe construite cu nu mai mult de patru etaje, prevederea d gunoi poate fi prin utilizarea de jgheaburi, sau de containere de depozitare a deșeurilor cu ventilație liberă. În bocurile construite cu mai mult de patru etaje, sunt recomandate jgheaburi (cu excepția cazului în care sunt instalate aparate cu combustibil solid). Jgheaburile ar trebui să se scurgă în containere mari, într-un magazin. Orice astfel de magazin ar trebui să fie proiectat, construit și întreținut pentru a reduce, în măsura în care este posibil, invazia de dăunători. De asemenea, trebuie amplasate, proiectate, construite și întreținute astfel încât să nu permită aerului de la magazin a intra în orice spațiu locuibil.

- k) ES: Para prevenir las chinches en nuestro hogar, es necesario: limpiar y organizar las salas de estar, evitar el desorden en casa, lavar sábanas y mantas y secar en temperatura caliente, cubrir el colchón y somier con coberturas con cremallera.

RO: Pentru a preveni apariția gândacilor în casa noastră, este necesar: de curățare și organizarea spațiului locuit, reducerea dezordinii în casă, spălarea cearșafurilor, păturilor și uscarea pe setarea fierbinte, închiderea saltelei cu fermoar pe durata primăverii.

- l) ES: Eliminar agua. Todos los seres vivos, incluidas plagas, necesitan agua para sobrevivir. Arreglar las goteras en tuberías y no dejar que el agua se acumule en ningún sitio de nuestra casa. Por ejemplo, no dejar agua en las bandejas debajo de las plantas, bajo el refrigerador, o

en cubetas toda la noche. Elimine o seque restos de agua o materiales mojados. Incluso las humedades o una alta humedad en el aire puede atraer plagas.

RO: Elimină apa. Toate ființele vii, dăunători inclusiv au nevoie de apă pentru a supraviețui. Repară conductele neetanșe și nu lăsați apa să se acumuleze nicideunde din casa noastră. De exemplu, nu lăsați apa în tăvi dedesubtul plantelor, dedesubtul frigiderului sau în cuve pe durata nopții. Elimină urmele de apă sau scoate afară materialele umede. Inclusiv umezeala sau înalta umezeală în aerul ce poate atrage dăunători.

m) ES: Eliminar alimentos. Almacene los alimentos en recipientes de vidrio o plástico, y mantenga la cocina limpia y libre de grasa y aceites. No deje la comida de sus mascotas en la encimera o en el suelo por un periodo de tiempo prolongado. Ponga las sobras de comida y basura en cierres herméticos, en cubos de basura fuera del alcance de animales y vacíe los cubos frecuentemente.

RO: Elimină alimente. Înmagazinează produse alimentare în recipiente din sticlă sau plastic, și păstrează bucătăria curată și fără grăsimi și uleiuri. Nu lăsați hrana pentru animalele de companie pe teșghea sau pe podea pentru o lungă perioadă de timp. Pune resturile de alimente și gunoiul în coșuri sigilate, departe de animale și goliți-l frecvent.

n) ES: Elimine o bloquee escondites para plagas en el interior. Selle grietas y fisuras para el control del acceso de plagas. Bañe a sus mascotas regularmente, y lave cualquier alfombra o superficie donde acostumbren a estar para controlar la aparición de pulgas. Evite almacenar periódicos, bosas de papel y cajas durante largos periodos de tiempo. También revise si hay plagas en paquetes o cajas antes de llevarlos a casa.

RO: Eliminarea sau blocarea locurilor unde se pot ascunde dăunători. Sigilarea crăpăturilor și fisurilor entru a controla accesul dăunătorilor. Îmbăierea animalelor de companie în mod regulat, și spălarea covoarelor sau suprafețelor unde obisnuies să stea pentru a controla aspectul "purici". Evitați depozitarea de ziare, hârtie și cutii și pungi pentru perioade lungi de timp. De asemenea, verificați prezenta dăunătorilor în pachete sau cutii înainte de a le duce în casă.

o) ES: Elimine o bloquee escondites para plagas en el exterior. Elimine la madera apilada debajo o en los alrededores de su casa para evitar atraer las termitas y hormigas carpinteras. Elimine las plantas enfermas, podas de árboles y frutos caídos que puedan albergar plagas. Amontone las hojas caídas. Mantenga la vegetación, arbustos y abono al menos a 18 pulgadas de distancia de su casa.

RO: Eliminarea/blocarea locurilor ce ascund dăunători afară. Eliminați teancul de lemne sub sau în jurul casei, pentru a evita atragerea de termite și furnici dulgher. Eliminați plantele

bolnave, tăiați arborii și fructele căzute, care ar putea adăposti daunătorii. Adunați frunzele căzute. Păstrați vegetațiile, arbuștii la cel puțin 18 inch de casă.

p) ES: Elimine los criaderos. Limpie los excrementos de sus mascotas del jardín; éstos atraen moscas que pueden propagar bacterias. No acumule basura y desperdicios, ya que atraen ratones, ratas y otros roedores. Seque o barra los charcos de agua; el agua es un lugar de cría para los mosquitos y otras plagas. Asegúrese de que las tuberías de drenaje y otras fuentes de agua y desaguan lejos de su casa.

RO: Elimină reproducere dăunătorilor. Curata excrementele animalelor de companie din curtea ta, ele atrag mustele care pot răspândi bacterii. Nu acumula gunoi sau murdărie; atrage șoareci, șobolani și alte rozătoare. Scurgere sau mătura bălți de apă în picioare, apa este un loc de reproducere pentru țânțari și a altor dăunători. Asigurați-vă că țevile de scurgere și alte surse de apă se scurg departe de casa ta.

q) ES: Tenga un cuidado adecuado de todas las plantas que se encuentren en el exterior. Diseñe y mantenga el paisaje para limitar cubiertas vegetales densas, y arbustos que puedan proporcionar albergue y exponer al suelo para ser cavado. Mediante grava pesada o coberturas artificiales pueden ayudar a prevenir madrigueras. Jardines comunitarios o áreas similares pueden provocar un estímulo adicional si se utilizan como áreas para comer y si se permite la acumulación de residuos de alimentos derramados.

RO: Aveți grijă corespunzătoare a tuturor plantelor care sunt pe exterior. Proiectați și mențineți grădinaritul pentru a evita formarea unui strat gros de frunze și arbuști ce pot adăposti dăunători și ce pot expune solul la săpături. Pietrișurile grele sau gardurile vii artificiale pot ajuta la prevenirea vizuinelor. Grădini comunitare sau zone similare pot provoca un stimulent suplimentar dacă sunt folosite ca zone de luat masa și în cazul în care acumularea de deșeuri alimentare este permis.

r) ES: En la ciudad, las restricciones sobre la disposición de basura son estrictas, siendo uno de los objetivos es asegurarse de que la basura no se quede olvidada (dentro o fuera) donde las plagas puedan tener acceso. La eliminación y recogida de basura debe tener una programación.

RO: În oraș, restricțiile cu privire la gunoi sunt stricte, unul dintre obiective fiind acela de a se asigura că gunoiul nu se uita (în interiorul sau în afară), unde dăunătorii au acces. Eliminarea și colectarea gunoiului ar trebui să aibă un program.

s) ES: Use contenedores de basura a prueba de roedores, cubos de basura y compactadores, e inspeccione regularmente si tienen roturas, huecos o si faltan tapas. Asegúrese de que las tapas

se utilizan correctamente. Los roedores son buenos escaladores y pueden acceder fácilmente a una bandeja abierta.

RO: Utilizați containere de gunoi rezistente la rozătoare, pubele de praf și compactoare și inspectatiile riodic de rupere, lacune și capace lipsă. Asigură-te de folosirea corespunzătoare a capacelor de gunoi. Rozătoarele sunt buni cățărați și pot obține cu ușurință acces la coș deschis.

ELECTIRCAL HAZARD RECOMMENDATIONS

- a) ES: Las subidas de tensión, llamadas sobrecargas, en la red eléctrica no solo pueden ser debidas a relámpagos. Sus razones pueden ser varias: un cableado eléctrico desordenado o anticuado, o el uso de aparatos de alta potencia para la red. Inevitablemente, los equipos no se bloquean inmediatamente si se produce un breve pico de tensión. Pero si durante un tiempo prolongado se producen pequeñas fluctuaciones de tensión “torturando” la sensibilidad de los equipos electrónicos, después de un tiempo se quedarán fuera de servicio o comenzarán a funcionar mal.
- RO: Creșterile de tensiune, denumite "supratensiune", în rețeaua de electricitate, pot apărea nu numai din cauza fulgerelor, Motivele sunt diverse- cabluri electrice dezordonate sau vechi, sau utilizarea de dispozitive de mare putere pentru rețea. Inevitabil, aparatura nu se blochează imediat dacă se produce un vârf de tensiune de scurtă durată. Dar dacă pe o durată de timp îndelungată se produc fluctuații de tensiune, "chinuind" sensibilitatea echipamentelor electronice, după un timp, acestea vor rămâne în afara serviciului sau vor începe să aibă defecțiuni.
- b) ES: Desde la construcción de un inmueble, se prevén unos 40-50 años de servicio del cableado eléctrico y otros equipos, dejando de cumplir los requisitos de seguridad contra incendios. El aislamiento se desgasta, el cableado se calienta y pudiendo causar incendios, sobre todo si la red está sobrecargada. El resultado de una sobrecarga de la red eléctrica es que automáticamente se apagan los interruptores. Ahora en todos los hogares hay muchos aparatos eléctricos, para los cuales no hay suficiente energía para su funcionamiento en viejas instalaciones eléctricas; los habitantes a menudo no son conscientes del riesgo, y de manera inadmisible aumentan el número de tomas de corriente. Con frecuencia las condiciones de sobrecarga de la red empeoran más rápidamente. Todo esto puede causar un incendio. Con el fin de no exceder la carga en la red eléctrica, en la fachada de cada casa o apartamento, se instalarán fusibles o disyuntores. Si el usuario no quiere un potencia muy alta, se instalarán disyuntores trifásicos de 10A (permiten una carga de 4-5kW), o disyuntores monofásicos de 16A (carga de 3kW). Si se instala un fusible

monofásico de 25A, la carga permitida es de hasta 5kW. Bajo un acuerdo con la compañía de la red eléctrica, se pueden contratar otras potencias y otros dispositivos diferenciales.

RO: De la construirea unei clădiri, după 40-50 de ani de funcționare, cablurile electrice și alte echipamente nu mai oferă aceleași condiții de siguranță. Izolarea este uzată, cablurile se încălzesc și pot provoca incendii, mai ales în cazul în care rețeaua este supraîncărcată. Rezultatul unei supraîncărcări a rețelei este că acesta se oprește automat. Acum, în fiecare gospodărie există mai multe dispozitive electrice, pentru care nu există suficientă putere de la vechea instalație electrică în funcțiune iar oamenii sunt de multe ori inconștienți de riscul la care se expun prin folosirea unui număr prea mare de prize, cabluri, conectoare. De multe ori o rețea supraîncărcată frecvent se agravează mult mai repede decât una necongestionată. Acest lucru poate provoca un incendiu. Pentru a nu depăși sarcina pe grila, pe fațada fiecărei case sau apartament, sunt instalate sisteme de siguranță sau întrerupătoare de circuit. În cazul în care utilizatorul nu dorește o putere foarte mare, va fi instalat întrerupătoare de circuit 10A cu trei faze (permite o sarcină de 4 - 5kW) sau întrerupătoare monofazate 16A (arcină 3 kW) . În cazul în care este instalată o singură fază 25 Amperi siguranță, sarcina admisă este de până la 5kW. Conform unui acord cu compania de rețea, puteți avea parte și de alte puteri și alte dispozitive de curent.

- c) ES: Antes de enchufar los aparatos eléctricos de mayor potencia (lavadoras, calentadores, hornos) a una vieja red eléctrica, compruebe la carga admisible del cableado y si es necesario aumentar sus secciones transversales. Si se excede la carga del cableado, estos aparatos deberán estar conectados a la red en línea independiente o podría ser necesario incrementar la potencia del sistema de red. Sin embargo, la potencia puede ser incrementada, no incrementando la instalación de interruptores diferenciales o fusibles, sino con la autorización del proveedor eléctrico.

RO: Înainte de a pune din priză aparatele electrice de mare putere (mașini de spălat haine, încălzitoare, cuptoare) de la rețeaua electrică veche, verificați sarcina limită admisă a cablului și dacă este necesar să creșteți secțiunile transversale. Dacă sarcina cablului este depășită, aparatele de uz casnic trebuie conectate la rețea în linie separată sau trebuie crescută puterea rețelei electrice. Totuși, puterea nu poate fi mărită prin instalarea de întrerupătoare de curent de circuit nominale mari sau fite, ci doar cu autorizarea furnizorului de energie electrică.

- d) ES: El cableado eléctrico debe ser reemplazado después de 40 años de su explotación, ya que su aislamiento plástico se endurece y se agrieta; y los dispositivos eléctricos – interruptores, tomas de corriente- debido al desgaste de las piezas móviles, cada 30 años.

RO: Cablurile electrice ar trebui înlocuite după 40 de ani de exploatare deoarece izolarea plastică se întărește sau prezintă fisuri iar dispozitivele electrice-intrerupatoare, prize datorită uzurii lor - o dată la 30 de ani.

- e) ES: Particularmente el gran riesgo está en aquellas casas donde el cableado instalado es bifásico, ya que no tienen toma a tierra, por lo tanto son una fuente potencial de peligro para la vida. Cambiar o mejorar el cableado solo puede ser realizado por especialistas con licencia o certificados de las empresas eléctricas estatales. Primeramente todo especialista evaluará al usuario y sus necesidades en el hogar, el ámbito de trabajo y los términos y sólo después calculará los gastos, cambiado solo el precio acordado cuando las exigencias del propietario cambien. El especialista preguntará el esquema de diseño de los enchufes e interruptores eléctricos, y en el caso de no existir, después de consultar con el propietario la disposición de los muebles, hará tal esquema y el cálculo de la potencia requerida, la carga, la cantidad de material sin aumentar o timar. El especialista siempre le aconsejará sobre dónde instalar el cuadro principal de alimentación, los enchufes o los conectores. La mejor manera para implementar estas recomendaciones es mediante la contratación de un especialista en instalaciones eléctricas.

RO: Casele unde cablurile electrice sunt cu două fire pentru că nu există cablul prin pământ, prezintă un risc și mai mare, de aceea uzarea lor prezintă un pericol pentru viață. Schimbarea sau îmbunătățirea cablului se poate face doar de către specialiști cu certificate sau licențe emise de companii de stat. În primul rând, specialiștii vor analiza utilizatorul și nevoile sale de uz casnic, domeniul de activitate, termenii și numai apoi va calcula cheltuielile, în timp ce prețul convenit se va schimba doar atunci când cerințele proprietarului se schimbă. În primul rând, specialistul va cere schema prizelor și a întrerupătoarelor, și dacă nu există, după consultarea cu proprietarul, unde acesta intenționează să pună mobilă, el va face o schemă, calculând puterea necesară, încărcarea, cantitatea materialelor fără incrementarea lor sau fără a înșela. Specialistul întotdeauna îți va da sfaturi: unde să se instaleze panoul principal de alimentare, prizele sau conectorii. Pentru angajarea unui maestru pentru instalații electrice se vor utiliza recomandări, ce sunt luate de la surse de încredere.

- f) ES: Con un pequeño presupuesto, usado para la renovación del cableado, la modernización del sector eléctrico se puede lograr en varias etapas: primero son necesarios realizar algunos trabajos de reparación. Aunque por lo general se invierte poco dinero en la instalación eléctrica, vale la pena elegir electrodomésticos eficientes, usar detectores de movimiento para la

activación de la luminaria en pasillos, lámparas de bajo consumo y reguladores de luz (dimmers) en las habitaciones.

RO: Cu un buget mic, folosit pentru reînnoirea cablurilor, modernizarea sectorului electric poate fi realizată prin diverse etape: în primul rând sunt necesare lucrări de reparație. Deși, în general, se investesc puțini bani în instalația electrică, merita se se aleagă aparate de uz casnic eficiente. În coridoare ar trebui să se utilizeze detectoare de mișcare, lămpi economice, în timp ce în camere ar trebui să se instaleze regulatoare de lumină.

g) ES: Las protecciones más simples para las fluctuaciones de tensión y sobretensiones son los cables eléctricos con filtros de alimentación integradas. Algunos de ellos los encontramos en las redes de ordenadores y conexiones telefónicas, que también están protegidos ante fluctuaciones de tensión. Los enchufes múltiples también pueden ser usados con todos los dispositivos que desee proteger. Antes de comprarlos debe saber qué tipo de dispositivos va a conectar a él para elegir el apropiado. La protección contra sobretensiones debe ser instalada en todas las etapas, empezando en la fachada de la casa, en un cuadro separado, y terminando en los enchufes e interruptores.

RO: Cele mai simple protecții împotriva fluctuațiilor de tensiune și supratensiune sunt cablurile electrice cu filtre de alimentare integrate. Unele dintre ele le întâlnim la rețeaua de calculatoare sau la conexiunile telefonice, ce, de asemenea, sunt protejate împotriva fluctuațiilor de tensiune. Prelungitoarele multiple de asemenea se pot utiliza cu dispozitivele pe care dorim să le protejăm. Înainte de a le cumpăra, ar trebui să știi ce fel de dispozitive vor fi conectate la ea și în concordanță cu acestea se va alege cel corespunzător. Protecția împotriva supratensiunilor ar trebui instalată în toate etapele - începând cu fațada casei, un panou separat de apartament și terminând cu priză sau prin ea pornind alte întreruptoare.

h) ES: El riesgo potencial de electrocución requiere que existan medidas de seguridad adecuadas. Cabe destacar el alto nivel de seguridad eléctrica encontrado en la mayoría de los hogares de Reino Unido, donde la incidencia de una descarga eléctrica en las viviendas es relativamente rara.

RO: Riscul potențial de electrocutare cere instalarea mijloacelor de securitate necesare și reflectând cel mai mare standard de protecție electrică găsit în majoritatea caselor din Marea Britanie, riscul de incidente datorită șocurilor electrice în locuințe, scade considerabil.

i) ES: La protección ante descargas eléctricas viene proporcionada por aislamientos y/o aislantes. Las partes activas deben estar cubiertas con materiales no conductores, para reducir el riesgo de descarga eléctrica. Todas las partes metálicas de una instalación deben estar conectadas a

tierra, para que en el caso de alguna deficiencia, el flujo de corriente vaya directamente a tierra, quedando activo un sistema de seguridad contra descargas eléctricas. Otras partes metálicas expuestas son tuberías de gas y agua, las cuales también deben ser conectadas a tierra.

RO: Protecția împotriva șocurilor electronice este asigurată de izolare și/ sau izolație. Părțile active trebuie acoperite cu un material non-conductor pentru a reduce riscul de șoc electric. Toate părțile metalice expuse ale instalației trebuie legate în pământ, astfel încât, în cazul unui deficit, orice curent imediat va avea fluxul înspre pământ, redând sistemului siguranță împotriva șocurilor electrice. Alte elemente metalice expuse cum ar fi conductele de gaz sau apă, ar trebui de asemenea conectate la borna principală din pământ.

- j) ES: Si se utilizan equipos que funcionen a 230V o más, para proporcionar una seguridad adicional se puede hacer uso de dispositivos de corriente residual (RCD). Estos pueden ser incorporados en la unidad de consumo. Los RCD son dispositivos que detectan algunas, pero no todas, de las deficiencias en el sistema eléctrico y rápidamente corta el suministro.

RO: Dacă echipamentul funcționează cu 230 volți sau mai mult, un dispozitiv de curent rezidual (DCR) 38 poate oferi mai multă siguranță. Acestea pot fi încorporate în unitatea de consum. Un DCR este un dispozitiv care detectează câteva, dar nu toate, deficiențe în sistemul electric și oprește rapid alimentarea.

- k) ES: El agua es un buen conductor, que aumenta los peligros de la electricidad. Esto significa que necesitamos medidas de seguridad adicionales en baños, cocinas y otras zonas donde los individuos pueden estar en contacto con agua y electricidad (por ejemplo en duchas eléctricas). No debe haber tomas de corriente en los baños que no sean de 12v AC.

RO: Apa este un bun conductor, ceea ce crește pericolele la electricitate. Înseamnă că trebuie luate măsuri suplimentare în bai, bucătării și în alte zone în care persoanele fizice ar putea fi puse în contact cu apă și o sursă de energie electrică (de exemplu, dușuri electrice). Nu ar trebui să existe în baie, prize cu putere mai mare de 12 volți curent alternativ (CĂ) (de exemplu, priză pentru bărbierit).

- l) ES: El agua es un buen conductor, que aumenta los peligros de la electricidad. Esto significa que necesitamos medidas de seguridad adicionales en baños, cocinas y otras zonas donde los individuos pueden estar en contacto con agua y electricidad (por ejemplo en duchas eléctricas). No debe haber tomas de corriente en los baños que no sean de 12v AC.

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să existe în baie, prize cu putere mai mare de 12 volți curent alternativ (CĂ) (de exemplu, priză pentru bărbierit).

m) ES: Los sistemas de protección contra rayos deben estar presentes en aquellos lugares donde haya riesgo de caída de rayos. Es especialmente importante en edificios altos y aislados, y su ubicación depende de la localización geográfica.

RO: Un sistem de protecția la fulgere ar putea fi nevoie să fie folosit dacă există un risc inacceptabil la trazine. Acest lucru este deosebit de relevant la clădirile înalte și izolate și este dependent și de poziția geografică.

n) ES: La iluminación de los cuartos húmedos se ejecutará de conformidad con los siguientes requisitos:

Zona I – protección clase IP44

Zona II – protección clase IP24 (e IP21)

Zona III – protección clase IP24 (e IP21)

Los elementos de iluminación en zona I y II serán fijados. La instalación debe de ser ejecutada usando materiales aislantes, y los soportes deben estar completamente aislados y protegidos de la entrada de humedad en la fuente de emisión de luz.

RO: Iluminatul camerelor umede trebuie executat în conformitate cu următoarele cerințe:

Zona No. 1 - clasa de protecție IP44,

Zona No. 2 - protecție IP24 clasă (și IP21), și

Zona No. 3 - clasa de protecție IP24 (și IP21).

Elemente de iluminat în zona nr.1 și 2 trebuie să se fixeze. Dacă instalația a fost executată folosind materiale izolante și, în cazul complet, izolate și protejate de pătrunderea umidității la sursa de emisie a luminii.

o) ES: Los ventiladores deberán estar diseñados para una tensión de 230V, y deberán ser de clase IP21 cuando sean instalados en muros. El mecanismo deberá estar conectada a un relé de fuga a tierra y estará instalado a una altura de 1,7m por encima del suelo. En este caso se permiten dispositivos de puesta a tierra con doble aislamiento, por ejemplo en equipos de audio, secadoras, ect. No toque los dispositivos anteriormente mencionados con las manos mojadas o mientras está en contacto con agua.

RO: Ventilatoarele ar trebui proiectate pentru o tensiune de 230 V, și ar trebui să fie clasa IP21 când sunt instalate în perete. Recipientul trebuie să fie conectat prin releu de scurgere și trebuie instalat la 1,7 m înălțime deasupra podelei. În acest caz, dispozitive de pământ cu dubla izolație

sunt permise, de exemplu, echipament audio, uscătoare. Nu atingeți dispozitivele menționate mai sus cu mâinile umede sau în timp de aveți contact cu apă.

- p) ES: En baños y cuartos con duchas se recomienda usar dispositivos de puesta a tierra en los dispositivos eléctricos como lámparas de mesa, lámparas de pie, aspiradoras, equipos de audio, secadores, lámparas ultravioleta, etc.

RO: În bai și în încăperi cu dus, se recomanda utilizarea conectorilor de pământ pentru dispozitivele electrice cum ar fi: lămpi de masă, lămpi cu picior, aspiratoare, echipament audio, uscătoare, lampe ultraviolete, etc.

- q) ES: La primera zona, situada por encima de la bañera, no se permite ningún mecanismo eléctrico.

La segunda zona podría incluir mecanismos eléctricos, por ejemplo para máquinas de afeitarse, con protección clase IP24, y la tensión del mecanismo será de 110V. Deberán estar instalados a una altura de 1,7m por encima del suelo.

La tercera zona podría incluir mecanismos de 230V con una protección clase IP21 o IP20. El mecanismo deberá estar conectada a un relé de fuga a tierra y estará instalado a una altura de 1,7m por encima del suelo. En este caso se permiten dispositivos de puesta a tierra con doble aislamiento, por ejemplo en equipos de audio, secadoras, etc.

No toque los dispositivos anteriormente mencionados con las manos mojadas o mientras está en contacto con agua.

- RO: Regulamentele electrice în baie se divid în trei arii independente:

În prima zonă, situată deasupra căzii din baie, nu se permite niciun recipient electric.

A doua zonă ar putea include recipiente electrice pentru bărbierit electric cu o protecție de IP24, tensiune de 110 V, Acești recipiente ar trebui instalați la 1,7m înălțime deasupra podelei.

A treia zonă, ar trebui incluse mecanisme de 230 V cu o protecție de clasă IP21 și Ip24. Ar trebui conectați de rețeaua de scurgere în pământ și montați la 1,7 m înălțime deasupra podelei.

În acest caz este permis că dispozitivele cu dubla izolare să fie permise, spre exemplu, echipament audio, uscătoare, etc.

Nu atingeți dispozitivele mai sus menționate cu mâinile umede sau când aveți contact cu apă.

- r) ES: Nunca intentar reparar los cables con cinta aislante. Esta cinta suele despegarse y dejar nuevamente los cables al descubierto, poniendo en riesgo a cualquier persona que los toque sin darse cuenta de la rotura, o también provocar un cortocircuito y posterior incendio.

RO: Nu încercați niciodată să reparați cablurile cu bandă izolantă. Această bandă obișnuiește să se dezlipească și să lase din nou cablurile descoperite, supunând la risc orice persoană care le atinge fără să realizeze ruptura, putând provoca un scurt-circuit sau un incendiu.

- s) ES: La plancha es uno de los electrodomésticos que jamás debe quedar enchufado luego de su uso, ya que se recalienta y seguramente provocara un cortocircuito. Nunca debe quedar enchufada sobre la ropa por más que sean solo unos minutos. Este es uno de los errores mas frecuentes y que producen un alto índice de incendios en el hogar.

RO: Fierul de călcat este unul din aparatele de uz casnic ce niciodată nu ar trebui să se lase în priză după folosirea lui, deoarece se reîncălzește și cu siguranță va provoca un scurt-circuit. Niciodată nu trebuie lăsat în priză deasupra rufelor, chiar dacă este doar pentru câteva minute. Acesta este una dintre cele mai frecvente erori comise și care produce multe incendii în casă.

- t) ES: Los cuadros eléctricos estarán dotados de sistemas de seguridad (diferenciales y magnetotérmicos).

RO: Ablourile electrice vor fi dotate cu sisteme de siguranță (diferențiale și întrerupătoare de circuit).

- u) ES: No se colocarán los cables sobre hierro, tuberías, chapas o muebles metálicos.

RO: Nu se vor pune cabluri pe fier, țevi, cerceafuri, metal sau mobilier metalic.

BIBLIOGRAPHY

REFERENCES

1. Ahmed, A., Korres, N. E., Ploennigs, J., Elhadi, H., & Menzel, K. (2011). Mining building performance data for energy-efficient operation. *Advanced Engineering Informatics*, 25(2), 341-354.
2. American Lung Association. (2002). American Lung Association State of the Air 2005. *American Lung Association National Headquarters, New York City, NY*.
3. Atkinson, R. W., Ross Anderson, H., Sunyer, J., Ayres, J. O. N., BACCINI, M., VONK, J. M., ... & KATSOUYANNI, K. (2001). Acute effects of particulate air pollution on respiratory admissions: results from APHEA 2 project. *American journal of respiratory and critical care medicine*, 164(10), 1860-1866
4. Baker-Laporte, P., Elliott, E., & Banta, J. (2008). *Prescriptions for a Healthy House: A Practical Guide for Architects, Builders & Homeowners*. New Society Publishers.
5. Battersby, S. (2011). Are Private Sector Tenants Being Protected Adequately? A study of the Housing Act 2004, Housing Health and Safety Rating System and Local Authority Interventions in England. Online.
6. Brook, R. D., Franklin, B., Cascio, W., Hong, Y., Howard, G., Lipsett, M., ... & Tager, I. (2004). Air pollution and cardiovascular disease A statement for healthcare professionals from the expert panel on population and prevention science of the American Heart Association. *Circulation*, 109(21), 2655-2671.
7. Centers for Disease Control and Prevention and U.S. Department of Housing and Urban Development (2006) *Healthy housing reference manual*. Atlanta: US Department of Health and Human Services.
8. City of London: Pest Control Service Leaflet. Integrated Pest Management. Some Advice on Good Practice.
9. Cohen, A. J., Ross Anderson, H., Ostro, B., Pandey, K. D., Krzyzanowski, M., Künzli, N., ... & Smith, K. (2005). The global burden of disease due to outdoor air pollution. *Journal of Toxicology and Environmental Health, Part A*, 68(13-14), 1301-1307.
10. Como hacer para. Retrieved 11/23, 2013, from <http://hogar.comohacerpara.com/n5548/como-prevenir-incendios-causados-por-problemas-electricos.html>

11. Csóka J., Deszpoth I., Gáti A., Maros Zs., et al. (1993) *The technology level quality control model system of house-like components*. Control Engineering Practice 1 (2), pp. 412.
12. Davidson, M., Roys, M., Nicol, S., Ormandy, D., & Ambrose, P. (2010). The real cost of poor housing.
13. Department for Communities and Local Government (2006). *Housing Health and Safety Rating System. Guidance for Landlords and Property Related Professionals*. Department for Communities and Local Government: London.
14. English Housing Survey. *Homes Report 2010*. (2010)
15. Environmental Management Centre, 2006. Environmental Management Centre, A comparison of ambient air quality standards applied worldwide.
16. España. Ministerio de Ciencia, & Tecnología. (2003). *RBT: Reglamento electrotécnico para baja tensión e instrucciones técnicas complementarias:(Real Decreto 842/2002, de 2-08-2002).. Protección de la salud y seguridad de los trabajadores frente al riesgo eléctrico:(Real Decreto 614/2001, de 8-06-2001)*. Creaciones Copyright.
17. Gangloff-Kaufmann, J. L., & Pichler, C. (2008). Guidelines for prevention and management of bed bugs in shelters and group living facilities. *New York State IPM Program, Cornell University*.
18. Grossman, C. M., Nussbaum, R. H., & Nussbaum, F. D. (2003). Cancers among residents downwind of the Hanford, Washington, plutonium production site. *Archives of Environmental Health: An International Journal*, 58(5), 267-274.
19. Hashim, A. M., & Dawal, S. Z. M. (2012). Kano Model and QFD integration approach for Ergonomic Design Improvement. *Procedia-Social and Behavioral Sciences*, 57, 22-32.
20. Hayashi, M., Enai, M., & Hirokawa, Y. (2001). Annual characteristics of ventilation and indoor air quality in detached houses using a simulation method with Japanese daily schedule model. *Building and Environment*, 36(6), 721-731.
21. HHSRS worked examples. (2007) Bristol CC examples.
22. HHSRS worked examples. (2007) CLG Worked examples.
23. HHSRS worked examples. (2007) IDeA Worked examples.
24. Howarth P., Reid A. (2000) *Sunbury Healthy House*, Mitchell Beazley, pp. 118-123
25. Hubbell, B. J., Hallberg, A., McCubbin, D. R., & Post, E. (2005). Health-related benefits of attaining the 8-hr ozone standard. *Environmental Health Perspectives*, 113(1), 73.
26. Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS). (2007) *La prevención de riesgos en los lugares de trabajo*. Guía para una intervención sindical.

**HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO
LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL
HAZARD**

27. Jacobs, DE; Friedman, W; Ashley, P; McNairy, M. (1999) *The Healthy Homes initiative: A preliminary plan*. Washington, DC: US Department of Housing and Urban Development
28. Kaklauskas A. (1999) *Multiple criteria decision support of building life cycle: research report presented for DrSc: technological sciences, civil engineering (02T)*, Ph.D. Thesis, Vilnius Gediminas Technical University.
29. Kaklauskas, A., Zavadskas, E. K., & Trinkunas, V. (2007). A multiple criteria decision support on-line system for construction. *Engineering Applications of Artificial Intelligence*, 20(2), 163-175.
30. Living in Wales Survey. (2006)
31. Mahdavinejad, M., & Mansoori, S. (2012). Architectural design criteria of socio-behavioral approach toward healthy model. *Procedia-Social and Behavioral Sciences*, 35, 475-482.
32. Office of the Deputy Prime Minister (2006). *Housing Health and Safety Rating System. Operating Guidance*. Office of the Deputy Prime Minister: London.
33. Schoenwetter, W. F. (1997). Building a healthy house. *Annals of Allergy, Asthma & Immunology*, 79(1), 1-4.
34. Scottish House Condition Survey. (2011)
35. Šliogeriene, J., Kaklauskas, A., Zavadskas, E. K., Bivainis, J., & Seniut, M. (2009). Environment factors of energy companies and their effect on value: analysis model and applied method. *Technological and Economic Development of Economy*, 15(3), 490-521.
36. US Environmental Protection Agency (EPA), US Environmental Protection Agency (EPA), Revisions to the National Air Ambient Air Quality Standards for particulate matter, Fed. Regist. 52, pp. 24634–24669 (1987)
37. US Environmental Protection Agency. (2005). *Citizen's Guide to Pest Control and Pesticide Safety*. Government Printing Office.
38. Wales - *Housing Demolitions and Hazards 2011-12*. (2011).
39. wikiHow. Retrieved 11/20, 2013, from <http://www.wikihow.com/Choose-the-Right-Lighting-for-Each-Room>

FIGURES

- FIGURE 2.1. CLASSIFICATION OF HAZARDS IN DWELLING PAG. 9
- FIGURE 2.2. 29 CRITERIA SYSTEM PAG. 11
- FIGURE 2.3. SUBCRITERIAS OF DOMESTIC HYGIENE, PESTS AND REFUSE PAG. 11
- FIGURE 2.4. LIGHTING PROBLEMS PAG. 12
- (1) http://farm4.static.flickr.com/3418/3889505207_53ee1f21d9.jpg
- (2) http://2.fimágenes.com/i/5/9/10/am_91558_4998903_858397.jpg
- (3) http://2.bp.blogspot.com/-DAIjKP_6BKM/UW7K6DEfHLI/AAAAAAAAABKM/UNw1WU41JTo/s1600/Worst+Window+View.jpg
- (4) http://s1304.photobucket.com/user/karlyoung1/media/theworstveiwfromawindow_zps840aaeb1.jpg.html
- FIGURE 2.5. NOISE PROBLEMS PAG. 14
- (1) http://i.telegraph.co.uk/multimedia/archive/01867/Property-clinic_1867863b.jpg
- (2) http://i.dailymail.co.uk/i/pix/2013/12/16/article-0-14B90813000005DC-477_634x400.jpg
- (3) http://www.cuatro.com/noticias/coches-contaminacion-ruido-ciudades_MDSIMA20120424_0031_4.jpg
- (4) http://static.noticiasdenavarra.com/images/2013/12/04/ubn_9348_jpg_20121220222256_5047_1.jpg
- FIGURE 2.6. BLOCK-DIAGRAM OF PROPERTY MARKET VALUE ESTIMATION PAG. 29
- FIGURE 3.1. HHSRS AND ITS COMPOSITE PARTS PAG. 32
- FIGURE 3.2. THE COMPONENTS OF HHS SYSTEM PAG. 33
- FIGURE 3.3. A COMPREHENSIVE QUANTITATIVE AND CONCEPTUAL DESCRIPTION OF THE HOUSING HEALTH AND SAFETY PAG. 34
- FIGURE 3.4. INITIAL DATA CONTENTS PAG. 35
- FIGURE 3.5. DOMESTIC HYGIENE, PESTS AND REFUSE PROBLEMS PAG. 38
- (1) http://www.trulynolen.com/images/pest_control/four_seasons/4s_theProblem_main.jpg
- (2) <http://www2.ca.uky.edu/entomology/entfacts/images/bedbughide.jpg>
- (3) http://i.dailymail.co.uk/i/pix/2008/07/16/article-1035426-01F8C3D800000578-724_468x356.jpg
- (4) http://img.irtve.es/files/74-161496-FOTO_NOTA_PRENSA_399/cocina_desordenada.jpg
- FIGURE 3.6. ELECTRICAL HAZARD PROBLEMS PAG. 41
- (1) <http://www.diaadia.com.ar/files/rayos.jpg>

HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL HAZARD

(2) <http://withablast.com/wp-content/uploads/2013/10/Hidden-Wall-Socket-Charging-Station2.jpg>

FIGURE 3.7. LIGHTING CRITERIA EXAMPLE	PAG. 50
FIGURE 3.8. NOISE CRITERIA EXAMPLE	PAG. 50
FIGURE 3.9. DOMESTIC HYGIENE, PESTS AND REFUSE CRITERIA EXAMPLE	PAG. 51
FIGURE 3.10. ELECTRICAL HAZARD CRITERIA EXAMPLE	PAG. 51
FIGURE 3.11. EVERLAST® LIGHTING CALCULATOR TOOL KIT	PAG. 54
FIGURE 3.12. DIALUX	PAG. 55
FIGURE 3.13. NOISELAB CALCULATOR	PAG. 56
FIGURE 3.14. NOISE CALCULATOR	PAG. 57
FIGURE 3.15. ELECTRICAL TOOLS (E-TOOLS) CALCULATOR	PAG. 58
FIGURE 4.1. KOLOR AUTOPANO GIGA 3.0 PROGRAM	PAG. 59
FIGURE 4.2. PANORAMIC VIEWS CREATED	PAG. 60
FIGURE 4.3. KOLOR PANOTOUR PRO 1.8 PROGRAM	PAG. 61
FIGURE 4.4. VIRTUAL HOUSE INTELLIGENT SYSTEM - BEDROOM	PAG. 62
FIGURE 4.5. VIRTUAL HOUSE INTELLIGENT SYSTEM - BATHROOM	PAG. 63
FIGURE 4.6. VIRTUAL HOUSE INTELLIGENT SYSTEM – NOISE EXAMPLE	PAG. 64
FIGURE 5.1. FACILITY GROUPS OF HEALTH AND SAFE RECOMMENDATION SYSTEM	PAG. 66
FIGURE 5.2. DESCRIPTION OF ALTERNATIVES OF HEALTH AND SAFE RECOMMENDATION SYSTEM	PAG. 66
FIGURE 5.3. MULTICRITERION ASSESSMENT OF DOMESTIC HYGIENE, PESTS AND REFUSE	PAG. 67
FIGURE 5.4. HEALTH RECOMMENDATION ADVISORY SYSTEM	PAG. 68
FIGURE 5.5. ADDITIONAL ADVISORY QUESTIONS OF HEALTH RECOMMENDATION SYSTEM ABOUT LIGHTING.	PAG. 69
FIGURE 5.6. RECOMMENDATIONS TO THE USER.	PAG. 69

**HEALTHY HOUSE AND VIRTUAL HOUSE INTELLIGENT SYSTEM. APPLIED TO
LIGHTING, NOISE, DOMESTIC HYGIENE, PESTS AND REFUSE AND ELECTRICAL
HAZARD**

TABLES

TABLE 1.1. SEARCH RESULTS	PAG. 5
TABLE 2.1. RESULTS OF WINDOWS ALTERNATIVES MULTIPLE CRITERIA ANALYSIS	PAG. 26
TABLE 2.2. GROUPED DECISION MAKING MATRIX OF CONSTRUCTION ALTERNATIVE'S MULTIPLE CRITERIA ANALYSIS	PAG. 26
TABLE 2.3. CALCULATION OF AVERAGE DEVIATIONS OF THE PROPERTY UTILITY DEGREES	PAG. 28
TABLE 2.4. A GROUPED DECISION MAKING MATRIX FOR PROPERTY MULTIPLE CRITERIA ANALYSIS	PAG. 30

GRAPHICS

GRAPHIC 1.1. EVOLUTION OF THE INTEREST OF THE KEYWORDS	PAG. 6
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