perfection

SEVENTH FRAMEWORK PROGRAMME

PERFECTION – Performance Indicators for Health, Comfort and Safety of the Indoor Environment

FP7 Grant Number 212998

D 1.1
An inventory of relevant standards, regulations and technologies

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1. INTRODUCTION

The PERFECTION project focuses on health, comfort, feeling of safety and positive stimulation indicators including accessibility and indoor environmental quality indicators integrated within a sustainable, low-energy built environment. In addition to these, other important indoor performance indicators are contemplated as part of a generic framework, such as adaptability, service life or usability.

The project aims at the review of performance indicators used in design, construction and use, and the identification of areas where new indicators for health and safety (including accessibility and indoor environmental quality) should be developed.

The first step of PERFECTION WP1 is to draw up an inventory of current performance indicators, standards, regulations, guidelines, research activities and policies used in design and construction of the built environment. The focus is on health and comfort (indoor environmental quality), accessibility, feeling of safety and positive simulation indicators but an overall framework for building performance indicators integrated within a sustainable built environment will be elaborated.

1.1. Focus and objectives

The deliverable D1.1 represents an inventory of standards, regulations, technologies across Europe (but also outside) related with indoor performance integrated within sustainable built environment.

The D1.1 comes out together with deliverable D1.2 in form of a database on relevant ongoing and recent research efforts and policies on indoor performance integrated within sustainable built environment.

D 1.1 & D1.2 will provide the basis for the production of a framework that will be developed and serves as a solid basis:

- to structure the making of a Compendium for Health & Comfort and Accessibility & Safety Indicators;
- to make the analysis for indoor performance indicators still to be developed;
- to formulate later recommendations for design and technologies.

Collection of the information inputs to D1.1 and D1.2 was performed by an extensive survey among all the PERFECTION partners and the whole expert network. The description of the whole process follows in chapter 2.

1.2. Definition of indoor environment quality

People in developed countries spend in buildings in average more than 90 % of the life. Residents or workers are often concerned that they have symptoms or health problems from exposures to contaminants in the buildings where they live or work. One reason for this concern is that their symptoms often get better when they are not in the building. Despite the fact that the information available from medical tests and tests of the environment is not sufficient to establish which contaminants are responsible, research shows that building-related symptoms are associated with building characteristics, including dampness, cleanliness, and ventilation characteristics. Indoor environmental quality addresses the subtle issues that influence how we feel in a space.

Indoor environments are highly complex and building occupants may be exposed to a variety of contaminants (in the form of gases and particles) from office machines, cleaning products, construction activities, carpets and furnishings, perfumes, cigarette smoke, water-damaged building materials, microbial growth (fungal/mold and bacterial), insects, and outdoor pollutants. Other factors such as indoor temperatures, relative humidity, and ventilation levels can also affect how individuals respond to the indoor environment.
Understanding the sources of indoor environmental contaminants and controlling them can often help prevent or resolve building-related worker symptoms. Practical guidance for improving and maintaining the indoor environment is available. By improving indoor environment healthier buildings would be created for the entire population, that's why PERFECTION will provide an Indicator Toolbox and User Decision Support Tool with final purpose to improve indoor environmental quality. This tool will target product developers, who develop innovative and PERFECTION related products and services and end users (individuals, builders, designers, etc.), whose purchase decisions will be supported.

1.3. Indicator categories-analysis

Providing indoor environment quality integrated within a sustainable, low-energy building means a delicate balance of various parameters. Those parameters are listed below.

1.3.1. Comfort

The indoor environment can provide comfort in terms of thermal, lighting and acoustic comfort.
- hygrothermal comfort (suitable indoor temperature, humidity and air movement);
- lighting comfort (suitable light levels and a pleasant environment);
- acoustic comfort (low noise levels and disturbances);

Hygrothermal comfort
Building occupants are always in search of thermal comfort, which in turn influences a person's performance (intellectual, manual and perceptual). Depending on the available means, occupants will attempt several actions to change or control environmental conditions. In order to be most successful in these actions, one must have a thorough quantitative, as well as qualitative, knowledge of the conditions establishing the parameters that influence thermal comfort. This will also enable building designers, to provide alternative means to the occupants for controlling their thermal comfort conditions, instead of lowering the thermostat during summer or increasing it during winter.
The human body is like a complex internal combustion engine. To achieve hygrothermal comfort, the body must balance its heat gains and losses by properly adjusting its functions (i.e. perspiration), while also responding to the prevailing environmental conditions (i.e. temperature and humidity). Under good conditions the human body can function at optimum levels.
There are times, however, that comfort cannot be achieved by the functions of the body itself, due to the severity of the prevailing conditions. Under such circumstances it is necessary to provide some assistance, either by natural, hybrid or mechanical means. It is important though, for rational use of available energy resources, to first exhaust all means of achieving comfort by natural or hybrid techniques and reducing heating and cooling loads, before having to resort to energy consuming mechanical systems.
Depending on the function of the building and its various spaces, indoor environment conditions will vary significantly, since occupants' needs are different. Clearly, there are significant variations of indoor conditions depending on the use of the building (i.e. offices,

factories, shops, hospitals, schools, theatres, restaurants, hotels, athletic halls, museums, computer rooms, etc).

The most important parameters that influence hygrothermal comfort are: dry bulb temperature, relative humidity, air velocity, barometric pressure, clothing, and activity. Hygrothermal comfort can be achieved by many different combinations of these variables. In all cases, it is the end result that we are interested in achieving, which means that, it is the combined effect of these parameters on the human body that is important. The positive or negative effect of one parameter on comfort may be enhanced or counterbalanced by the change of another parameter. The body's thermal equilibrium is a dynamic balance between heat production (as a result of human metabolic rate) and body heat transfer by convection, conduction, radiation and evaporation to or from the environment.
Sweating and the resulting evaporative cooling sensation, is the main mechanism of thermal adjustment for the human body, under hot environmental conditions or high level of activity. Clothing will directly influence the amount of heat and mass (moisture) exchange from the body to its environment.
The control of environmental conditions in order to achieve hygrothermal comfort can be performed by:

- Passive controls (on the environment, clothing, metabolic rate), and
- Active or hybrid controls (on the building).

Hygrothermal comfort is directly dependent on air ventilation systems (natural, hybrid or mechanical) that supply the necessary amounts of fresh air, which is controlled in terms of quantity, velocity, quality and thermal conditions. Indoor thermal conditions are primarily influenced by indoor temperature and relative humidity. The indoor temperature is defined in terms of air temperature and internal wall surface temperature in a given space (radiant temperature). The relative humidity is the ratio of the mole fraction of water vapor in a given moist air sample, to the mole fraction in an air sample, saturated at the same temperature and pressure. Most air-conditioning systems are in fact used to primarily remove the excess water vapor from the air.

Lighting comfort
Proper indoor lighting provides sufficient light in the right place at the time required. This enables the occupants to see easily and in comfort, allowing them to perform their tasks efficiently without strain or fatigue. Good indoor lighting enhances the appearance of a space and provides a pleasant working environment or attractive leisure area. Daylighting refers to the admittance of natural light (solar radiation) into internal spaces. It is a key factor in the design of energy efficient commercial buildings. When it is properly used, it can reduce the need for artificial (electrical) lighting thus resulting in substantial energy savings. When daylighting is not sufficient, localized artificial task lighting can be used to supplement. Most occupants prefer to supplement the available daylight during the early morning and late afternoon hours (depending on the availability of daylight and the orientation of the space's openings). Artificial lighting must of course be adequate in order to cover the needs for indoor lighting after sunset, when no daylight is available, or in spaces completely enclosed by opaque materials. Building designers must recognize the importance of daylighting and the appropriate selection of electric lights in visual comfort, as well as their effects on energy conservation. It is essential to identify the design options and their synthesis to achieve energy conservation, including possible use of both daylighting and electric lighting with controls to reduce electric lighting automatically when daylight is available.
The light quality criteria which must be taken into account when one designs the lighting of indoor environments, are lighting level, luminance distribution in the optical field, reduction of direct or indirect glare, light direction and shades, light colors. Each time these criteria must be

properly adapted to satisfy the specific requirements of a given space. The order must also be properly adjusted according to the function of the space.
Of course, it is necessary also to satisfy the proper light levels. Achieving comfortable luminance ratios in any space requires a careful study of all the factors involved, like light sources and the reflectance of surfaces (i.e. ceiling, walls, floors, and furniture). For lighting comfort, it is necessary to create a proper balance between the luminance of the immediate task and that of the adjacent surfaces in the field of view, avoiding both excessively dark backgrounds and distracting bright surroundings.
Daylight is considered the best source of light for good color rendering. Each light source (natural or artificial) has a specific wavelength distribution, which defines its composition. All surfaces also reflect incident light in a certain band of wavelengths, depending on their color.
Daylight availability inside a building depends on location and on the form of the building, the size and orientation of the windows. When the primary source of daylight is entering a space through a south-facing window, then the depth of a space for adequate natural illumination should be limited to the range of 2 to 2.5 times the window height. For an average window height of 2 m, this means a maximum space depth of 4 m to 5.5 m. This will ensure that sunlight will penetrate the entire space. Indoor spaces near windows can easily be daylighted, but it is also possible to redirect and properly distribute solar radiation for a more uniform illumination of indoor spaces.

Acoustic comfort
One of the primary parameters of indoor environmental quality for a well designed building is the protection of the building from outdoor and indoor noise. The building envelope protects the occupants from the outdoor sources. The mechanical heating, cooling and ventilation systems and their components must be designed, installed and operated in such a way that any noise they may cause inside the building or neighboring buildings (i.e. from outdoor units and system components) are at levels that do not cause any serious discomfort or health problems that may disturb the occupants.
The sound is produced from a source and follows a certain path as the wave travels from the source, until it reaches the final receiver. In order to control or interrupt the sound transmission, it is possible to intervene at any point of the sound travel path or at various stages at the same time. When the sound levels exceed the acceptable ranges, then they are characterized as noise and they cause disturbance.

Noise can originate from:

- the outdoor environment - sound is transferred into the space through openings, the building envelope and the air ducts of the ventilation system, if they exist;
- the ventilation and air-conditioning equipment - when the equipment or some system components operate inside the building and because of air distribution;
- the indoor spaces - sound travels either through the internal partitions and walls inside the building, or either through the ventilation system and the air ducts or other mechanical systems, if they exist, inside the space.
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Depending on the function of a space, there are specific noise levels that are considered acceptable and depend on parameters including:

- Activity levels - the use of the space for specific work functions is related to how occupants perceive and accept certain noise levels. For example, depending on the concentration effort and the type of work they perform, noise levels can be perceived as more or less disturbing.
- Psychological factors - the occupants' psychological condition may affect how a noise problem (along with all the other indoor conditions) is perceived, even the same person with the same space conditions, but at different time periods.

- Adaptiveness - a very important factor since humans can adapt to the prevailing conditions of the environment they live or work in. For example, people that spend most of their lives living and working in urban environments (i.e. downtown areas in large cities) develop a higher tolerance to noise levels, even under difficult conditions with high noise levels.
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The most common noise problems originate from the main air handling units of central HVAC installations and they are usually low frequencies (less than 250 Hz) and they also range between 12-40 Hz. Other sources may from the outdoor units, usually located on the roof of the building, like large size heat pumps and cooling towers, and may also create a problem. Indoor noise related problems that come from central ventilation or/and the air-conditioning installations, are usually linked to the operation of fans. The sound frequency and intensity depends on various factors like the number, type (centrifugal or axial), vane tilt, total pressure drop, rotating speed, air flow velocity etc. Selecting a fan with the lowest possible rotations per minute (rpm) is usually best for maintaining low noise levels.
The means for noise attenuation to maintain comfort conditions include:

- Sound insulation - ensure appropriate wall and slab constructions that meet the criteria set at design are specified. The constructions specified will need to be tested on site after construction to ensure transmission loss criteria are met.
- Internal noise levels including partition/wall constructions and speech privacy - the internal finishes should be developed to meet reverberation time criteria for the various spaces.
- The design of the HVAC systems will need to include appropriate noise control to meet the internal noise levels specified at scheme design stage.
- In open office areas where speech privacy may be an issue the specification of a noise masking system may be required.
- Control noise based on internal fit out design. Consider using white noise to aid privacy in open offices.

1.3.2. Health

Indoor air quality
Indoor air quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.
There are many sources of indoor air pollution in any home. These include microbial contaminants (mold, bacteria), gases (including carbon monoxide, radon, and volatile organic compounds), particulates, or any mass or energy stressor that can induce adverse health conditions. Indoor air is becoming an increasingly more concerning health hazard than outdoor air. Using ventilation to dilute contaminants, filtration, and source control are the primary methods for improving indoor air quality in most buildings.
Health effects from indoor air pollutants may be experienced soon after exposure or, possibly, years later. There are immediate effects which may show up after a single exposure or repeated exposures. And long-term effects which may show up either years after exposure has occurred or only after long or repeated periods of exposure.

Immediate effects include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Symptoms of some diseases, including asthma, hypersensitivity pneumonitis, and humidifier fever, may also show up soon after exposure to some indoor air pollutants.

Long-term effects include some respiratory diseases, heart disease, and cancer, can be severely debilitating or fatal. It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable.
While pollutants commonly found in indoor air are responsible for many harmful effects, there is considerable uncertainty about what concentrations or periods of exposure are necessary to produce specific health problems. Further research is needed to better understand which health effects occur after exposure to the average pollutant concentrations found in homes and which occurs from the higher concentrations that occur for short periods of time.
There are though certain strategies which can improve indoor air quality. Those include source control, ventilation improvements and air cleaners.

Source Control
Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, like those that contain asbestos, can be sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions. In many cases, source control is also a more cost-efficient approach to protecting indoor air quality than increasing ventilation because increasing ventilation can increase energy costs.
Ventilation improvements
Good ventilation protects residents from unpleasant odors, irritating pollutants, and potentially dangerous gases like carbon monoxide and radon. Well-planned ventilation also prevents the growth of mold and mildew, which can cause or aggravate allergic reactions and lung problems such as asthma. So, ventilation is another approach to lowering the concentrations of indoor air pollutants. This can be also affected with zero cost by increasing the amount of outdoor air coming indoors. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Opening windows and doors, operating window or attic fans, when the weather permits, or running a window air conditioner with the vent control open increases the outdoor ventilation rate. Local bathroom or kitchen fans that exhaust outdoors remove contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate. Though in some cases outdoor pollutants are more than indoors, so in this case opening the windows can't provide indoor air quality.
Air cleaners
There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive table-top models to sophisticated and expensive whole-house systems. Some air cleaners are highly effective at particle removal, while others, including most table-top models, are much less so. Air cleaners are generally not designed to remove gaseous pollutants. Using air cleaner to reduce levels of radon and its decay products is not recommended.

Quality of drinking water
The health and livelihood of citizens depends a lot on the availability of a safe drinking water supply. Both community and private sources of drinking water are susceptible to a myriad of chemical contaminants, biological pollutants and nuisance water problems that may vary depending on site conditions and other factors. Some of the more common chemical pollutants include pesticides, fertilizers, petroleum products, and industrial solvents. Some problem organisms, including viruses, bacteria, protozoa and algae, cause nuisance problems with taste and odor while others are potential pathogens.
EC in order to protect human health laid down healthiness and purity requirements in the directive 98/83/EC, which must be met by drinking water within the Community.
This directive enforces Member States to ensure that drinking water:

- does not contain any concentration of micro-organisms, parasites or any other substance which constitutes a potential human health risk;

- meets the minimum requirements (microbiological and chemical parameters and those relating to radioactivity) laid down by the Directive.

It applies to all water intended for human consumption apart from waters which are medicinal product. [1]

1.3.3. Safety

Many occupants are injured or die in and around their homes. Though safety in buildings isn't univocal and depends from several parameters, the most important of which are listed below:

Seismic safety

Seismic safety refers to precautions that are taken to prevent occupants of a building from getting injured or die in an earthquake event. To reinforce a building against earthquakes safety measures have to be taken not only during the design of construction, but also during the buy of furniture and appliances, which shouldn't be moved around and hurt somebody. There are also measures that are taken from the occupants during the earthquake.

Fire safety

Fire safety refers to precautions that are taken to prevent or reduce the likelihood of a fire that may result in death, injury, or property damage, alert those in a structure to the presence of a fire in the event one occurs, better enable those threatened by a fire to survive, or to reduce the damage caused by a fire. Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building.

Electricity hazards

Electrically powered equipment, such as hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultrasonicators, power supplies, and microwave ovens are essential elements of many word areas. These devices can pose a significant hazard to workers, particularly when mishandled or not maintained. Many electrical devices have high voltage or high power requirements, carrying even more risk. Large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. There also some precautions that when workers follow them can significantly reduce electrical hazards (e.g. inspect wiring of equipment before each use).

Other safety issues

Some other requirements are the following:

- Adequate washrooms & toilet facilities
- Proper air circulation
- Ample sunlight
- Clearances for emergency vehicles
- Noise mitigation measures
- Safeties in lifts (falling, door interlocks, railings around car roof, seismic provisions, fire-lift)
- Exit signage, gensets, emergency lights

1.3.4. Accessibility

Many buildings lack of special provisions for the disabled people regarding accessible buildings and facilities. The framework that will be developed in WP1 aim at providing the structure of making a Compendium for Health & Comfort and Accessibility & Safety Indicators
To design, to the extent possible, public buildings accessible to all certain consideration should be taken into account.
Buildings that have to comply with accessibility requirements for the disabled include all public buildings, governmental facilities and institutions, office buildings, residential buildings, commercial buildings, health facilities, educational institutions restaurants, recreational facilities, sports facilities, religious buildings and all other building types normally used by the general public.
Except as specified below, only buildings for private use, such as private residences, clubs, offices or studios, etc. need not comply with requirements for accessibility for the disabled.
For accessible buildings, at least one entrance per facility should be accessible to a wheelchair user. For new buildings, the accessible entrance(s) should be the main entrance(s) intended for use by the general public.
Wherever waiting areas, coffee shops, display areas, merchandising departments, service areas, ticket counters, refreshment stands, etc. are provided for public use, these facilities should be accessible to disabled people, mainly to wheelchair users.
All work areas in which physically disabled persons may be employed should be accessible.
In any public rest room, at least one unisex compartment should be accessible to a wheelchair user.

1.3.5. Energy

Energy effective buildings can be produced by taking measures during the design process. Successful low or zero energy building designers typically combine time tested passive solar or natural conditioning, principles that work with the onsite assets. Sunlight and solar heat, prevailing breezes, and the cool of the earth below a building, can provide daylighting and stable indoor temperatures with minimum mechanical means.

These types of buildings are usually built with significant energy-saving features. The heating and cooling loads are often drastically lowered by using high-efficiency equipment, added insulation, high-efficiency windows, natural ventilation, and other techniques. These features can vary drastically between buildings in different climate zones. Water heating loads can be lowered using water conservation fixtures, heat recovery units on waste water, and by using solar water heating, and high-efficiency water heating equipment. In addition, free solar daylighting with skylites or solartubes can provide 100 % of daytime illumination. Nighttime illumination is typically done with fluorescent and LED lighting that use 1/3 or less of the power of incandescent lights, without adding unwanted heat that incandescent lights do. And miscellaneous electric loads can be lessened by choosing efficient appliances and minimizing phantom loads or standby power. Other techniques to reach energy efficiency (dependent on climate) are Earth sheltered building principles, superinsulation walls using strawbale construction, and exterior landscaping for seasonal shading.
Such buildings are often designed to make use of energy gained from other sources including white goods; for example, use refrigerator exhaust to heat domestic hot water, ventilation air and shower drain heat exchangers, office machines and computer servers, and even body heat from rooms with multiple occupants. These buildings make use of heat energy that conventional buildings typically exhaust outside. They may use heat recovery ventilation, hot water heat recycling, combined heat and power, and absorption chiller units.
In European Union, Member States by 31 December 2018 at the latest must ensure that all newly-constructed buildings produce as much energy as they consume on-site - e.g. via solar panels or heat pumps, amending the 2002 Energy Performance of Buildings Directive.

Parliament also wants Member States to set intermediate national targets for existing buildings, i.e. to fix minimum percentages of buildings that should be zero energy by 2015 and by 2020 respectively.
Parliament added new provisions to the text which require Member States to draw up national action plans by mid-2011 setting out financial instruments for improving the energy efficiency of buildings, such as low-interest loans, fiscal rebates on income or property taxes or requiring energy suppliers to offer financial assistance to consumers.
A building's energy performance will have to be upgraded to meet at least minimum energy performance requirements whenever it undergoes major renovation or building components and technical building systems (such as windows, boilers or air conditioning systems) are replaced, says the amended text.
Members of the European Parliament (MEPs) define a "major renovation" as a refurbishment of more than 25 % of the building's surface or where the total costs of the renovation are higher than 25 % of the building's value, excluding the value of the land upon which the building is situated, or those where more than 25 % of the building shell undergoes renovation.
The minimum energy performance requirements are to be set by the Member States, says the directive. However, the Commission will have to establish a common methodology for calculating the energy performance of buildings by 31 March 2010, add MEPs. Holiday homes must meet minimum energy performance standards, too. [2]

1.3.6. Economic indicators

Costs over the whole life of the building, taking into account running and maintenance costs, as well as the initial costs of construction, must always be considered in relation to standards. The resources for buildings are money, operatives, materials and machinery. All affect the degree of expenditure of money and the overall economy of a building project. The total cost of a building however is made up over its all useful life of the capital cost as also for the cost of maintaining it in a useful condition. Reducing initial cost may lead to increased maintenance and running cost during its life.
Energy consumption is closely linked to economic indicators. As energy efficient buildings save a lot in energy consumption and as a consequence in cost. For example to achieve lighting comfort one must provide the necessary light levels to indoor spaces. Windows must be designed for heat losses and/or gains and surface temperatures consistent with occupant comfort and energy conservation. Optical and thermal properties of glazing determine the overall process. During summer, when solar radiation intensity is higher, one needs to control incoming solar radiation in order to be able to achieve thermal comfort and minimize direct solar gains. During winter, the incoming solar radiation has a positive impact by providing the desirable natural lighting and by satisfying some of the heating requirements of the space. However, even during a clear winter day, solar radiation can cause overheating, especially when the building has large glazed surfaces.
For example, during a clear summer day in Athens (Greece), the maximum outside light levels will reach 100,000-120,000 lux, whilst on a dark overcast winter day this might fall to around 15,000-20,000 lux. The recommended minimum light intensities for a space are expressed as illuminance values, and they depend on the function of the space. For example, they may range from 100 lux in a corridor to 300 lux in the average office, and 1000 lux in a well-lit supermarket. Accordingly, some thoughtful building design can exploit the available daylighting to satisfy most of the indoor lighting needs.
Another parameter that affects indoor environment quality is indoor air quality. The most cost-effective approach to reduce indoor air pollution is by controlling the source of contaminants instead of increasing ventilation because increasing ventilation can increase energy costs. For example some sources, like those that contain asbestos, can be sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions.

1.3.7. Positive stimulation

Positive stimulation is another important parameter that PERFECTION deals with but unfortunately hasn't gone that far. Positive stimulation refers to helping occupants of a building with environmental features to elicit positive feelings in a building, while stimulatig them to stay in the building and not in another place. Lack of positive stimulation can be numbing and depressing for the occupants.

For example, environments that are stimulating for babies and young children are filled with safe objects to explore, allow freedom of movement, and provide a variety of experiences. A stimulating environment can be created in one room of a home, in a home child care setting, or in a center-based environment. The most important aspect of a stimulating environment is a caregiver (or caregivers) who can create inviting, challenging play spaces in which to interact with babies and young children, can set limits and be emotionally available to babies and young children, and can read babies' and young children's cues and support them when they become overstimulated, fatigued, or bored.

Another type of stimulating environment might be a hospital with environmental features such as artwork, music, an aquarium, water elements, healing gardens etc. The core principle of pleasant diversion is reducing patients' preoccupation with their pain and illness through sensory stimulation that elevates mood and coping skills.

A building with special provisions for people with disabilities and elder people would be also considered as a positive stimulating environment.

2. DESCRIPTION OF WORK

2.1. Wide network survey

To create an inventory of standards, regulations, guidelines, technologies, as also a database on relevant ongoing and recent research efforts and policies across Europe and outside related to indoor performance integrated with sustainable built environment, some work tasks took place. At first, an online set of questionnaires was developed. All of the PERFECTION partners and also the network partners provided inputs for ongoing and recent research efforts. All of the filled questionnaires can be read at the end of this document in Annex 1-5.
The collected input data was cleaned from duplicities and any irrelevant inputs and a database of associated standards, regulations, technologies, research activities and policy documents was created and is laid as an Annex 6 of this deliverable.
The database inputs were not only categorized by the region where the item was applicable, but were also linked to the main categories of relevant indicators:

- health;
- comfort;
- safety;
- accessibility;
- energy;
- economic indicators for the indoor environment.

Also sorting by the applicable building type was applied as follows:

- office;
- residential;
- commercial;
- educational;
- others.

Such categorization enables further sorting and much better orientation in the survey results.

2.2. Standards

Standards as technical documents are valuable source of information on the indoor environment of buildings and assessment thereof. There are several layers of the valid standards – regional, national, European, American and international standards issued by several standardization bodies.
The aim of the survey was to obtain a wide scope view on relevant standards used for design of the indoor environment. Some of the standards are compulsory which is marked in the database of results.

2.3. Regulations

Regulations are understood as broader set of regional, national and international legal documents that in hand with standards forms the way in which buildings are being designed, constructed and operated.

The survey was focused on the measures directly related to the indicators of the indoor environment. It was clear that complex coverage of all the regulations Europe-wide at all levels would take much more workforce than available in the project, but overview of actual state of the art is necessary for further work.

2.4. Technologies

The aim of technologies survey was to have an overview of technical means available for promotion of the indoor environment. Alike the research survey, which is focused on new ideas and future development, survey of existing technologies shows us solutions for the ongoing projects and projects ready to start in the next few years.

In the survey was at each piece of technology question on the level of availability – if the technology is commercially available or still in phase of industrial prototype. This detailed information is included in the enclosed Annex 6 – Database of collected information.

2.5. Research

By research are for the purpose of this survey and the Perfection project in general meant ongoing as well as finished research projects and publications related to the indicators of indoor environment. In most cases the indoor environment indicators are not primary object of investigation, but the research results application has impact on some of them.

2.6. Policies

Policy is considered to be a deliberate plan of action to guide decisions and achieve rational outcome(s). Policy may also be used to denote what is actually done, even though it is unplanned.

The term may apply to government, private sector organizations and groups, and individuals. Policy or policy study may also refer to the process of making important organizational decisions, including the identification of different alternatives such as programs or spending priorities, and choosing among them on the basis of the impact they will have. Policies can be understood as political, management, financial, and administrative mechanisms arranged to reach explicit goals.

Policy differs from regulation but can be considered as a complement to it. While regulations can compel or prohibit behaviors, policy merely guides actions toward those that are most likely to achieve a desired outcome.

3. SURVEY RESULTS

3.3. Total number of collected inputs

There was collected in total 308 complete inputs into the on-line survey. Statistical overview of the data obtained is in the Table 1 below.

Survey	Number of obtained inputs
Standards	114
Regulations	95
Technologies	21
Research	55
Policies	28
Total	313

Table 1: Overview of inputs obtained in survey

The extent and form of this deliverable do not allow incorporating into the text all the collected data in its complexity. Therefore it is put only basic overview of the obtained information in the following chapters. For the detailed information on a particular piece of standard, regulation, technology, research or policy stands whole database in a form of an excel sheet as an Annex 6 to this Deliverable D1.1-D1.2.

3.4. Indicators of the indoor environment listed in the survey

Accessibility of buildings
Accessibility of buildings for elderly people
Accessibility of housing in the UK
Acoustic comfort
Acoustic, visual, thermal comfort
Air quality
Air quality - material emission
Air quality - particles
Air tightness under 4 Pa
Biological agents exposure
Calorific potential of a zone
Comfort of disabled people
Comfort of internal coatings
Comfort of older persons
Concentration of carcinogens and mutagens
Concentration of certain chemicals
Concentration of certain Pb, Hg, Cd, Cr and PBB or PBDE.
Concentration of internal pollutants per m3 air
Conservation of fuel and power in buildings
Domestic access standards

Domestic Safety
Doors safety
Economic indicators for the indoor environment - sustainability
Electro-magnetic fields
Energy - sustainability
Energy consumption per square meter
Energy distribution
Energy efficiency
Energy management
Energy performance
Energy production
Energy requirements
Energy-efficient design
Energy-Net zero energy buildings
Exposure on mechanical vibration
Exposure to ionising radiation
Exposure to sound and sound level
Fiber emission
Fire reaction of materials
Fire resistance of materials
Fire safety
Global and spectral emergence
Health of elderly people
Health of indoor workplaces
Health-environmentally friendly products
Health-indoor hygiene/indoor air quality
Hot water maximal temperature
Hot water minimal temperature
HVAC control
Hygrothermal comfort
Indicator of the energy waste through infiltration
Indicator of the Leads Breakdown
Indoor Air Quality
Indoor environment
Integrated Energy Characteristics
Legionellosis Associated with Building Water Systems
Lightning
Machinery risks
Maximum acoustic level
Mean radiant temperature
Minimal lighting level
Moisture
More natural light
Mould growth
Natural ventilation
No cost system for ventilation
Non-Domestic accessibility standard UK
Operational temperature
Participation of user in the different planning phases
Quality of drinking water
Radioactive emission (mSv/yr)
Radon concentration

Removal of architectural barriers
Renewable energy production
Safety - lightning safety
Safety of indoor workplaces
Safety of internal coatings
Safety of supply systems
Safety-safety and risk of failure
Secondary material emissions
Temperature control
Thermal comfort
Thermal properties of buildings
Ventilation conditions
Ventilation rate
Visual comfort
VOC concentration
VOCs and formaldehyde emission
VOCs emissions
Warmth Infiltration Indicator
Width of the doors, the paths, etc.

3.5. Standards

3.5.1. Survey results

There were collected in total 114 inputs in the Standards survey. From the analysis of results structure (see table Table 2) is clear that from the six basic categories health and comfort are found as most important (36 % and 34 %). On the other hand the inputs related to the economic indicators of the indoor environment were the least frequent.

Category	Category share in Standards survey
Health	36 %
Comfort	34 %
Safety	13 %
Accessibility	5 %
Energy	9 %
Economic indicators for the indoor environment	4 %

Table 2: Categories shares in Standards survey

From the Table 3 bellow is clear that the obtained inputs in the Standards survey are more or less uniformly distributed among the building types. From other categorized building types are mostly mentioned public buildings and hospitals. Six of all 114 standards are applicable for any building type without restriction.

Building type	Number of applicable standards
All building types without restriction	6
Residential buildings	39
Office buildings	37
Commercial buildings	36
Educational buildings	34
Other occupancy types	
Public buildings	7
Hospital	5

Industrial	3
Cultural	2
Buildings for sanitary maters, social care	1
Workplaces	1
Non-domestic	1
Sport facilities	1

Table 3: Obtained Standards survey inputs and building types applicable

3.5.2. List of relevant standards

Basic overview of all relevant standards is in the following table. For more detailed information see Annex 6 – Database of collected information.

ID	Title	Description
66	Access to Buildings	An accessible environment is one that a disabled person can enter and make use of independently or with help from a partner or assistant. This Digest sets out basic requirements for accessible buildings which in making buildings more functional will be to the benefit of all users. It outlines the requirements of national building regulations and the Disability Discrimination Act, and summarizes access requirements inside and outside domestic and non-domestic buildings. Communication devices, access auditing and assistive technology are also discussed. 12 pages.
12	Access to Buildings for Disabled People	Access standard/code of practice for use by designers of non-domestic buildings in the UK. This standard covers access to and within non-domestic buildings.
13	Accessible Housing	Access to and around houses for use by designers in the UK. This is a voluntary standard that complements BS8300. It typically goes beyond regulatory requirements for access to housing.
113	AFNOR XP X46-021 Traitement de l'amiante dans les immeubles bâtis - Examen visuel des surfaces traitées après travaux de retrait de matériaux et produits contenant de l'amiante - Mission et méthodologie	Method to check asbesto removing works
114	AFNOR XP X46-023 Diagnostic amiante - Éléments de cartographie du repérage des matériaux et produits contenant de l'amiante dans les immeubles bâtis	Method to spot asbesto in buildings
112	ANSI/ASHRAE 140 - 2007 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs	this document provides a validation method for multizone thermal simulation tools, allowing an evaluation of thermal comfort
2	ANSI/ASHRAE 62.1-2007 Ventilation for Acceptable Indoor Air Quality	The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects.

ID	Title	Description
3	ANSI/ASHRAE 62.2-2007: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings (ANSI Approved)	This standard applies to spaces intended for human occupancy within single-family houses and multifamily structures of three stories or fewer above grade, including manufactured and modular houses. This standard does not apply to transient housing such as hotels, motels, nursing hornest, dormitories, or jails.
4	ANSI/ASHRAE 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings	This standard defines the roles of and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality in low-rise residential buildings
5	ANSI/ASHRAE 90.2-2007: Energy Efficient Design of Low-Rise Residential Buildings (ANSI/ASHRAE Approved)	The purpose of this standard is to provide minimum requirements for the energy-efficient design of residential buildings.
62	BDS CR 1752:2002	Ventilation for buildings - Design criteria for the indoor environment
63	BDS EN (BDS EN ISO)	All CEN standards related to HVAC systems and design of indoor environment are recognized as Bulgarian State Standards (BDS)
32	Binnenmilieu gerelateerde input parameters voor ontwerp en beoordeling van energieprestatie van gebouwen voor de kwaliteit van binnenlucht, het thermisch comfort, de verlichting en akoestiek	European Standard that forms part of a series of standards related to directive 2002/91/EC Energy Performance of Buildings (EPBD). NEN-EN 15251:2007 (E) is Dutch version of that standard.
31	Bouwfysische kwaliteit Rijkshuisvesting (Guideline Building Physical quality Governmental Buildings)	Includes (generally) performance based indoor environmental requirements for governmental building (mainly offices). It contains more strict requirements compared to the Dutch Building Decree and is often also applied for performance specification for non-governmental buildings in the Netherlands. It also provides target values and assessment methods (reference).
16	British Standard: BS EN 15251: 2007	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics
14	BS 8300:2008 - Design of buildings and their approaches to meet the needs of disabled people - Code of practice	BS 8300 explains how the built environment can be designed to anticipate, and overcome, restrictions that prevent disabled people making full use of premises and their surroundings
28	BS 9999:2008 Code of practice for fire safety in the design, management and use of buildings	BS 9999 gives recommendations and guidance on the design, management and use of buildings to achieve acceptable levels of fire safety for all people in and around buildings.
19	Building Energy Efficiency Standards	Since 1st January 2009 every new building in Poland needs to possess a certificate that indicates detailed technical and economical parameters of the building. It particularly summarizes the use of energy and information on possible alternative energy sources. These need to be in the range of acceptable values.

ID	Title	Description
33	Building. External and internal coatings. Analysis of requirements.	This standard aims at defining requirements to be satisfied by external and internal coatings of walls and ceilings. The requirements are organized in classes, depending on the main purpose they address, which can be related to safety, comfort (including aesthetic, acoustic, olfactory and visual comfort), and conservation of quality.
87	CEN CR 1752:2002 Ventilation for buildings - Design criteria for the indoor environment. 2002	CR 1752 Ventilation for buildings - Design criteria for the indoor environment.
23	CEN/TS 14383-4:2006 : Prevention of crime - Urban planning and design - Part 4: Shops and offices	This document provides guidance and a recommended strategy for combating burglary, theft, arson and other crimes committed against retailers and other businesses. It applies to both new and existing shops and offices
22	CEN/TS14383-3 :2005 : Prevention of crime - Urban planning and building design - Part 3 : Dwellings	This Technical Specification gives guidance and recommendations for reducing the risk of crimes against people and property in dwellings and their immediate surroundings through planning and design. It covers new and existing dwellings, in single or multiple units
64	Control of Substances Hazardous to Health (COSHH) Essentials guidance publications	Control of Substances Hazardous to Health (COSHH) Essentials guidance publications
53	ČSN 12 7010 Design of ventilating and air conditioning equipment. General regulations.	General regulation for design of HVAC systems
40	ČSN 36 0020 Integral lighting - Basic requirement	Basic requirements on natural, artificial and combined lighting
46	ČSN 73 0525 Acoustics - Acoustical design of rooms - General principles	Determine general principles of acoustical design of closed rooms used for listening of music and speech.
45	ČSN 73 0527 Acoustics - Acoustical design of rooms - Rooms for cultural uses - Rooms in schools - Rooms for public purposes	Room acoustic requirements
44	ČSN 73 0532 Acoustics - Protection against noise in buildings and related acoustic characteristics of building products - Requirements	Requirements for sound insulation between rooms in buildings, sound insulation of building envelope and transmission loss of doors and windows
38	ČSN 73 0540-2 Thermal protection of buildings - Part 2: Requirements	Thermal protection of buildings - basic requirements
39	ČSN 73 0580 Daylighting in buildings	Basic requirements on access to daylight
54	ČSN 73 0802 Fire protection of buildings - Non-industrial buildings	Fire protection, escape paths and escape times
56	ČSN 73 0804 Fire protection of buildings - Industrial buildings	Fire protection, escape paths and escape times
57	ČSN 73 0833 Fire protection of buildings. Buildings for dwelling and lodging	Fire protection, escape paths and escape times
58	ČSN 73 0835 Fire protection of buildings - Buildings for sanitary maters and social care	Fire protection, escape paths and escape times
59	ČSN 73 4108 Dressing rooms, lavatories and water-closets	General principles for designing of dressing rooms, lavatories and water-closets

ID	Title	Description
50	ČSN 73 4301 Residential buildings	General principles for designing of residential buildings or residential parts of buildings.
51	ČSN 73 5105 Industrial buildings for production purposes	General principles for designing and reconstruction of industrial buildings
52	ČSN 73 5305 Administration buildings and rooms	General principles for designing of administration buildings and rooms and of their reconstructions.
41	ČSN EN 12464-1 Light and Lighting - Lighting of work places - Part 1: Indoor work places	Requirements for lighting in indoor places
48	ČSN EN 13779 Ventilation for non-residential buildings. Performance requirements for ventilation and room-conditioning systems	Performance requirements for ventilation and room-conditioning systems for non-residential buildings
49	ČSN EN 15251 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting
42	ČSN EN 1838 Light and Lighting - Emergency Lighting	Requirements for emergency lighting in buildings
43	ČSN EN 50172 Emergency escape lighting systems	Requirements for emergency escape lighting in buildings accessible for public
47	ČSN EN ISO 717 Acoustics - Rating of sound insulation in buildings and of building elements	Definition of airborne sound and impact sound values for buildings, walls, ceilings, doors, windows.
105	DIN 18015-1 Normenausschauss Bauwesen (NABau)	this documents outlines design of electrical systems in residential buildings
102	DIN 18024-2 Normenausschauss Bauwesen (NABau)	document outlines requirements accessibility for disabled person for public buildings
103	DIN 18040-2 Normenausschauss Bauwesen (NABau)	this documents outlines which technical requirements and geometry of buildings will result in good disabled accessibility for public buildings
104	DIN 18040-2 Normenausschauss Bauwesen (NABau)	this documents outlines requirements for residential buildings and their exterior design for use for disabled person
97	DIN 5034 Normenausschauss Bauwesen (NABau)	definitions of basic concepts for indoor lighting with day light.
98	DIN 5035-3 Normenausschauss Bauwesen (NABau)	Guidance outlines requirements for lighting in hospitals using artificial lighting. Definition of room types and their specific lighting requirement.
99	DIN 5035-7 Normenausschauss Lichttechnik (FNL)	outlining specific requirements for working spaces i.e. using computer desks
88	DIN EN 12354-5 Normenaussschuss Bauwesen (NABau)	Calculation of acoustic performance of buildings. Part 5: Sound level of installation
89	DIN EN 12354-6 Normenaussschuss Bauwesen (NABau)	Calculation of acoustic performance in buildings. Part 6: Acoustic absorption in indoor environment
100	DIN EN 12464-1 Normenausschauss Lichttechnik (FNL)	Outlining requirements for lighting for working spaces. focus on natural and artificial lighting and a combination of both
93	DIN EN 13300 Normenausschauss Bauwesen (NABau)	coating material - water based coating material and coating systems for walls and ceilings in indoor environments

ID	Title	Description
94	DIN EN 14412 Normenausschauss Bauwesen (NABau)	Guidance for passive collectors for measurement of indoor quality. This guidance outlines a rating system to rate indoor environment quality
91	DIN EN ISO 13788 Normenausschauss Bauwesen (NABau)	outlining calculation methods for minimum values on inner walls to omit critical inner surface moisture (focus on mould building)
90	DIN EN ISO 13791 Normenausschauss Bauwesen (NABau)	Outlining of boundary assumptions, equations and validation testing for calculation of summer peak time indoor temperatures for individual rooms without heating.
92	DIN EN ISO 13792 Normenausschauss Bauwesen (NABau)	Calculation of minimum, average and maximum temperature in indoor environments. This document could be used during design phase. Document helps to avoid over heating of rooms, estimate if cooling is required. Criteria are outlined.
95	DIN EN ISO 16000-1 Normenausschauss Bauwesen (NABau)	General and specific guidance for material related aspects for preparing the measurement before and after testing phase.
96	DIN EN ISO 16017-1 Normenausschauss Bauwesen (NABau)	general guidance for testing and analysis of organic compound (VOC) in air for external air and indoor environments
29	EN 15251 (2007) Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics	This standard defines indoor input parameters for design and assessment of energy performance of buildings
34	EN ISO 7730:2005 Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria	Presents methods for predicting the general thermal sensation and degree of discomfort (thermal dissatisfaction) of people exposed to moderate thermal environments. It enables the analytical determination and interpretation of thermal comfort using calculation of PMV (predicted mean vote) and PPD (predicted percentage of dissatisfied) and local thermal comfort, giving the environmental conditions considered acceptable for general thermal comfort as well as those representing local discomfort.
86	EN ISO 7730:2005. Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria.	Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria.
8	Green Building Standard	The Israel Standard for Green Building (5281), approved by the Standards Institution of Israel in November 2005, consists of a series of criteria and requirements. Buildings that comply with these requirements are certified as green buildings. This "green label" serves both developers and consumers. It provides developers with a marketing advantage, proving the quality of their projects, and serves as a measure of the quality of the building and its usage for consumers.

ID	Title	Description
9	Guidelines for Sustainable Building	Properly managed, green pilot projects should yield reduced costs for the entire life of buildings, provide safer and more productive work environments, and prevent the inadvertent creation of pollution by-products that may later require costly remediation. In addition, the large quantities of construction and demolition waste which exist in Israel provide for the possibility of recycling and reuse. Therefore, green building guidelines and green demonstration projects are expected to accelerate the development of new markets for the reuse of recyclable materials.
35	Housing. Internal doors. Soft body impact test.	This standard defines tests to be done on internal doors in order to verify their level of resistance to soft body impacts. It applies to internal doors with rotatory movement on a vertical lateral axis destined to residential buildings, excluding glass doors and apartment's access doors.
67	Impact safety standards for glass	Results of research carried out by BRE to determine the impact energy and forces exerted in the glass impact and drop height tests specified in BS 6206 and its replacement, BS EN 12600. The two standards use different test methods and different glazing classification systems. BRE tested several different types of glass to both standards and the results are tabulated in this paper. They demonstrate that comparisons can be made across the classification systems and that there should not be a reduction in the safety of glass used in buildings in critical locations as long as the performance in the BS EN 12600 test at least matches that of the appropriate BS 6206 classification.
18	Indoor climate standards	Present indoor climate standards are developed on the concept of average person. However people are different and the concept of average person most often does not work in practice. The standards need to be update and modified to address this issue and make it possible to implement technologies for individually controlled environment in practice.
11	INIES database	French reference database about environmental and sanitary features of the building materials
109	ISO 15392 Sustainability in building construction — General principles	This International Standard presents general principles of sustainability related to buildings and other construction works. These general principles form the basis for a suite of standards intended to address specific issues and aspects of sustainability relevant to building and civil engineering of construction works.
69	ISO 16 000-6. 2004. Indoor Air Part – 6: Determination of volatile organic compounds in indoor and chamber air by active sampling on Tenax TA, thermal desorption and gas-chromatography MSD/FID.	Determination of volatile organic compounds in indoor and chamber air

ID	Title	Description
71	ISO 16000-10. 2006. Indoor Air – Part 10: Determination of the emission of volatile organic compounds from building products and furnishings – Emission test cell method.	Determination of the emission of volatile organic compounds from building products and furnishings – Emission test cell method
70	ISO 16000-9. 2006. Indoor Air – Part 9: Determination of the emission of volatile organic compounds from building products and furnishings – Emission test chamber method.	Determination of the emission of volatile organic compounds from building products and furnishings – Emission test chamber method.
110	ISO/TS 21929 Sustainability in building construction — Sustainability indicators Part 1: Framework for the development of indicators for buildings	This part of ISO/TS 21929 defines a framework for sustainability indicators for buildings based on the premise that sustainable construction achieves the required technical performance of the construction with the minimum of environmental impact.
111	ISO/TS 21931-1 Sustainability in building construction — Framework for methods of assessment for environmental performance of construction works — Part 1: Buildings	The purpose of this part of ISO/TS 21931 is to describe the framework and the principles behind the assessment of the environmental performance of both new and existing buildings, taking into account the various environmental impacts these buildings are likely to have.
6	KNX standard	The worldwide STANDARD for all applications in home and building control, ranging from lighting and shutter control to various security systems, heating, ventilation, air conditioning, monitoring, alarming, water control, energy management, metering as well as household appliances, audio and lots more. The technology can be used in new as well as in existing home and buildings
61	Ministry Regulation referred to the details and types of the building projects	It describes in detail all the formal requirements that the building project needs to fulfill. Such project consists then the basis on which the construction permit is issued.
10	National Strategy plan for Sustainable Development	
30	NBN EN 12464-1: Light and lighting - Lighting of work places - Part 1: Indoor work places.	This European standard specifies lighting requirements for indoor work places, which meet the needs for visual comfort and performance.
21	NBN EN 14383-1 : Prevention of crime - Urban planning and building design - Part 1: Definition of specific terms	This European Standard is the terminology part of a series for the “Prevention of crime by urban planning and building design”. For some specific terms used in the other parts, dealing with urban planning, dwellings, shops and offices, it provides equivalent terms in three languages, as well as definitions.
20	NBN EN 81-70:2003 Safety rules for the construction and installations of lifts - Particular applications for passenger and good passengers lifts - Part 70: Accessibility to lifts for persons including persons with disability	This European Standard specifies the minimum requirements for the safe and independent access and use of lifts by persons, including persons with the disabilities.

ID	Title	Description
27	NBN EN ISO 7730 (2006) : « Ergonomics of the thermal environment — Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (ISO 7730:2005) »	This norm give a method to determine the thermal comfort
25	NBN S 01-400-1 « critères acoustiques pour les immeubles d'habitation » (2008)	This norm defines comfortable acoustic level in building
24	NBN S 01-401 « Valeurs limites des niveaux de bruits en vue d'éviter l'inconfort dans les bâtiments » (1987)	This norm defines maximum acoustic levels in rooms in respect to their use. It takes in account exterior noise (i.e. traffic noise, industrial noise) and interior noise (devices noise, neighbour noise)
26	NEN 1070 « Geluidwering in gebouwen - Specificatie en beoordeling van de kwaliteit » (1999)	This norm give a method to quantify the acoustical levels by taking in account impact noise, aerial noise and devices noise
15	NEN 1814 - Toegankelijkheid van buitenruimten, gebouwen en woningen	This norm gives general requirement for the accessibility of buildings.
60	Polska Norma PN-EN 15251	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.
107	Protection of structures against lightning Part 1: General principles	The purpose of this standard is to provide a system against thunder in order to protect structures, people and objectives from dangerous that emerge from thunder. This standard project, installation, inspection and maintenance of system of protection against lighting
37	Publicatie 89 Binnenklimaat scholen	This publication presents practical guidelines for indoor climate and climate systems in schools (design, use, commissioning). Quality classes are applied to categorize the indoor climate.
65	Radon Barriers	Guidance on the installation of Radon Barriers to homes under the warranty of the National House Building Council

ID	Title	Description
68	Radon: guidance on protective measures for new buildings (including supplementary advice for extensions, conversions and refurbishment) (2007 ed)	This guide, which supports Building Regulations Approved Document L, offers practical guidance for reducing the concentration of radon in new buildings, extensions, conversions, and refurbishment projects. It has been prepared to help architects, designers, builders, and installers specify and install successful protective measures in order to reduce the risk to occupants of exposure to radon, which can cause lung cancer. The guide contains maps of England and Wales for identifying areas where radon protective measures should be installed. This 2007 edition of the report replaces guidance published in 1999. 53 pages. New maps with additional detail such as towns and road networks to help readers identify radon affected areas more easily. Additional drawings and photographs Additional guidance on protective measures suitable for new non-domestic buildings and extensions New guidance on protective measures for conversion and refurbishment projects and for suspended timber ground floors
108	Requirements for electrical installations	The purpose of this standard is to protect citizens and animals from the dangers that arise from electrical installation. To succeed that electrical installations have to follow certain requirements.
117	RT 07-10564 Rakennuksen sisäilmasto. (1995) Indoor climate in buildings	The guidance includes the instruction and design values to good indoor climate in respect of thermal comfort and indoor air quality as well as prevention of moisture problems
84	RT 07-10946. 2009. Indoor climate classification 2008. Target values for indoor climate, design instructions and product criteria. The Finnish Building Information Foundation RTS.	Target values for indoor climate, design instructions and product criteria.
85	RT –14-10675. 1998. Determination of the relative humidity in concrete structures. The Finnish Building Information Foundation RTS.	Relative humidity in concrete structures
82	RT 14-10775. 2003. Determination of the indoor air ammonia concentration. The Finnish Building Information Foundation RTS.	Indoor air ammonia concentration
83	RT 14-10776. 2003. Determination of the ammonia emission from surfaces. The Finnish Building Information Foundation RTS.	Ammonia emission from surfaces
115	RT STM-20929 Sosiaali- ja terveysministeriön päätös asuntojen huoneilman radonpitoisuuden enimmäisarvoista. Suomen säädöskokoelma 944/1992. (1993) - Radon concentration indoors, dwellings	Includes maximum Radon concentration both in new and old dwellings and guidance how and when to measure

ID	Title	Description
116	RT STM-21232 s Asumisterveysohje. Asuntojen ja muiden oleskelutilojen fysikaaliset, kemialliset ja mikrobiologiset tekijät. Sosiaali- ja terveysministeriön oppaita 2003:1. (2008) -Physical, chemical and microbiological impurities in dwellings	The guidance includes criteria/instructions for the thermal comfort, noise, air quality, relative humidity, radon etc
79	SFS 3860. 1988. Measurement of dust concentration in work place air by filter method. Finnish standards association SFS.	Dust concentration in work place air
80	SFS 3862. 1981. Air quality in work places. Determination of the formaldehyde concentration with the chromotrophic acid method. Finnish standards association SFS.	Determination of the formaldehyde concentration
81	SFS 5412. 1987. Air protection. Emissions. Combustion gases. Determination of carbon monoxide with non-dispersive infra red absorption method. Finnish standards association SFS.	Determination of carbon monoxide
78	SFS 5511. 1989. Air conditioning. Indoor climate in buildings. Field measurements of thermal conditions. Finnish standards association SFS.	Field measurements of thermal conditions.
74	SFS 5907. 2004. Acoustical classification of buildings. Finnish standards association SFS.	Acoustical classification of buildings
72	SFS-EN 12341. 1998. Air quality. Determination of the PM 10 fraction of suspended particulate matter. Reference method and field test procedure to demonstrate reference equivalence of measurement methods. Finnish standards association SFS	Determination of the PM 10 fraction of suspended particulate matter
76	SFS-EN 12464-1. 2003. Light and illumination. Illumination of work places. Part 1: Illumination of work places indoors. Finnish standards association SFS.	Illumination of work places
75	SFS-EN 13779. 2007. Ventilation for non-residential buildings. Performance requirements for ventilation and room-conditioning systems. Finnish standards association SFS.	Ventilation for non-residential buildings
73	SFS-EN 15251. 2007. Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. Finnish standards association SFS.	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

ID	Title	Description
77	SFS-EN 779. 2003. Particulate air filters for general ventilation. Determination of the filtration performance. Finnish standards association SFS.	Determination of the filtration performance.
7	SPC 188P - Proposed Standard authorized 6/30/05.Prevention Practices for Legionellosis Associated with Building Water Systems	The purpose of this standard is to present practices for the prevention of Legionellosis associated with building water systems. This standard provides design, environmental and operational practices for the prevention of Legionellosis associated with building water systems. This Standard applies to human occupied buildings, excluding single family residential buildings. While not specifically intended for non-centralized or single family residential building systems, some of the information may be useful for those systems.
36	Thermische behaaglijkheid - eisen voor de binnentemperatuur in gebouwen	This publication includes guidelines for the thermal indoor climate, specifically for offices. It includes the adaptive approach for buildings that are not mechanically conditioned.
106	VDI 6008 Blatt 1 VDI Gesellschaft Technische Gebäudeausrüstung	This document outlines requirements and design solutions (indoor and external) for accessibility focused on older and disabled person. focus on systems, maintenance, function, usability etc.
101	VDI 6011, VDI Gesellschaft Technische Gebäudeausrüstung	This document outlines components and system for using natural and artificial lighting.

Table 4: Overview of relevant standards (sorted in alphabetic order by title)

3.5.3. Standardization bodies

Name	Abbrev.	Website
American Society of Heating, Refrigerating, and Air-Conditioning Engineers	ASHRAE	http://www.ashrae.org
Belgian norm institute	NBN	http://www.nbn.be
Bulgarian Institute for Standardization	BDS	http://www.bds-bg.org
Czech Office for Standards, Metrology and Testing	COSMT	http://www.cni.cz
Dutch Government Buildings Agency	-	http://www.wweni.nl/pagina.html?id=37576
European Committee for Standardization	CEN	http://www.cen.eu
German Institute for Standardization	DIN	http://www.din.de
Instituut voor Studie en Stimulering van Onderzoek op het gebied van gebouwinstallaties	ISSO	http://www.isso.nl
International organisation for Standardization	ISO	http://www.iso.org
Israel Ministry of Construction and Housing	-	http://www.moch.gov.il
Israel Ministry of Environmental Protection	-	http://www.sviva.gov.il
KNX Association	KNX	http://www.knx.org
Nederlans Normalisatie-instituut	NEN	http://www.nen.nl
Polish Ministry of Infrastructure Regulation	-	http://www.en.mi.gov.pl
Polski Komitet Normalizacyjny	PKN	http://www.pkn.pl
The British Standards Institution	BSI	http://www.bsigroup.com
The Chartered Institution of Building Services Engineers	-	http://www.cibse.org
The Standards Institution of Israel	SII	http://www.sii.org.il
The Italian Organization for Standardization	UNI	http://www.uni.com

Table 5: Overview of relevant standardization bodies (sorted in alphabetic order by title)

3.6. Regulations

3.6.1. Survey results

There were collected in total 95 inputs in the Regulations survey. In the analysis of results structure (see Table 6) can be found share of basic six categories on the results. The mostly mentioned regulations related to the health issues (28 %), whereas the inputs related to the economic indicators of the indoor environment were the least frequent (only 2 %).

Category	Category share in Regulations survey
Health	28 %
Safety	23 %
Comfort	20 %
Energy	15 %
Accessibility	12 %
Economic indicators for the indoor environment	2 %

Table 6: Categories shares in Regulations survey

Table 7 shows that the obtained inputs in the Regulations survey are more or less uniformly distributed among the building types. From other categorized building types are mostly mentioned public buildings, workspaces and hotels. 29 of all 95 regulations are applicable for any building type without restriction.

Building type	Number of applicable regulations
All building types without restriction	29
Office buildings	34
Educational buildings	27
Residential buildings	26
Commercial buildings	23
Other occupancy types	
Public buildings	5
Workplaces	4
Hotels	4
Car parks	3
Health care	3
Catering services	2
Swimming pools	2
Museums	1
Theatres	1
Saunas	1
Sports premises	1
Barracks penitentiary	1
Hygiene rooms and other spaces in non-residential buildings	1
Buildings that use radioactive sources	1
Day-care establishments	1

Table 7: Obtained Regulations survey inputs and building types applicable

3.6.2. List of relevant regulations

ID	Title	Description
57	Act no. 183/2006 Coll., on landscape planning and building regulations (Building act)	-
58	Act no. 20/1966 Coll., on public health in the wording of later regulations	-
60	Act no. 258/2000 Coll., on protection of public health in valid wording	-
62	Act no. 262/2006 Coll., Labour code	-
69	Act no. 406/2006 Coll., on energy management (Energy management act)	-
28	Amendment of the provisions of Law 1577/85 related to the applicable Building Contractor Regulations	This law lays down the rules for the urban planning. Among this rules special regulation are assigned for the buildings that are built since 1985 in order to be accessible from disabled people, special modification are also done in this direction in statutory authorities.
18	Arrêté du 18 octobre 1977	Fire regulation for high-rise buildings
15	Arrêté du 24 mai 2006 (Réglementation thermique 2005)	Main thermal regulation for buildings applied today in France
16	Arrêté du 24 mars 1982	This regulation set the minimal ventilation rates for dwellings
19	Arrêté du 25 juin 1980	Fire regulation for public buildings
17	Arrêté du 30 novembre 2005	Regulation concerning legionella prevention.
20	Arrêté du 30 novembre 2007	-
35	Besluit van de Vlaamse regering houdende maatregelen tot bestrijding van de gezondheidsrisico's door verontreiniging van het binnenmilieu	Define the basics requirement concerning chemical and physical properties of the indoor environment
36	Besluit van de Vlaamse regering tot vaststelling van een gewestellijke stedenbouwkundige verordening betreffende toegankelijkheid	Requirement concerning the accessibility of buildings.
26	Building Decree 2003: Stb.2001, 410	Describes minimum requirements for building with respect to safety, health (mainly: sound, ventilation, lighting, materials, water), usability, energy and environment.
43	Building Regulation: Approved document Part F	Means of ventilation

ID	Title	Description
80	Building Regulations (Part L Amendment) Regulations 2008 (S.I. No. 259 of 2008): Technical Guidance Document L – Conservation of Fuel and Energy – Dwellings	Technical Guidance Document L provides guidance on the design and construction of new and existing dwellings so that they comply with the Building Regulations Part L: - how to comply with the requirements on energy performance and CO2 emissions; - for existing dwellings the key issues are: fabric insulation, air tightness, boiler efficiency, building services controls and insulation of pipes, ducts and vessels. - for new dwellings the key issues are: primary energy consumption and related CO2 emissions, use of renewable energy sources, fabric insulation, air tightness, boiler efficiency, building services controls, insulation of pipes, ducts and vessels, mechanical ventilation systems, performance of completed dwelling and user information.
82	Building Regulations 2000: Technical Guidance Document M – Access for People with Disabilities	Technical Guidance Document M provides guidance on the design and construction of buildings so that they comply with the Building Regulations Part M: - How to make adequate provision for safe and independent access, sanitary conveniences and audience or spectator facilities for people with disabilities.
79	Building Regulations 2002: Technical Guidance Document F, Ventilation	Technical Guidance Document F provides guidance on the construction of buildings so that they comply with the Building Regulations Part F: - how to provide adequate means of ventilation for people in buildings, including adequate provision for the removal of water vapour from kitchens, bathrooms and other areas where water vapour is generated. - how to make adequate provision to prevent excessive condensation in a roof or in a roof void above an insulated ceiling.
81	Building Regulations 2005: Technical Guidance Document L – Conservation of Fuel and Energy	Technical Guidance Document L provides guidance on the design and construction of new and existing buildings other than dwellings so that they comply with the Building Regulations Part L: - how to comply with the requirements on energy performance and CO2 emissions; - the key issues are: fabric insulation, boiler efficiency, building services controls, limitation of cooling need, efficient air-conditioning or mechanical ventilation if necessary, insulation of pipes, ducts and vessels, efficient artificial lighting systems
30	Building Regulations for England & Wales	Technical guidance to building regulations in England & Wales (UK) related to accessibility, safety and energy efficiency. The guidance is updated on a regular basis. For accessibility the guidance is based on BS8300.
29	Building Standards Scotland	Standards 4.1 and 4.2 of the Domestic Handbooks - relates to access to buildings and access within buildings respectively.
49	Byggingareglugerð (Building Regulation)	Building regulation for Iceland, covers all stipulated requirements for buildings and partly the built environment
14	Code de la santé publique	Public health code. Some parts concern the indoor environment

ID	Title	Description
9	COMMISSION DIRECTIVE 2006/15/EC establishing a second list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC and amending Directives 91/322/EEC and 2000/39/EC	The aim of this direction is to protect workers in the European Union from chemical risks due to exposure in work. To succeed that businesses are obliged to apply certain limits in chemical factors in which workers can be exposed.
31	Constructional law	This law lays down the basic rules for the building construction. Among those rules there are certain rules that refer to accessibility of disabled people. This concern ramps, handrails, sidewalks, elevators and mailboxes.
12	Council directive 2003/122/EURATOM of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources	The purpose of this Directive is to prevent exposure of workers and the public to ionising radiation arising from inade-quate control of high-activity sealed radioactive sources and orphan sources and define specific requirements ensuring that each such source is kept under control
101	COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption	The Directive is intended to protect human health by laying down healthiness and purity requirements which must be met by drinking water within the Community. It applies to all water intended for human consumption apart from and waters which are medicinal products.
27	CWATUP: Code Wallon de l'Aménagement du Territoire, de l'Urbanisme et du Patrimoine et de l'énergie	Define the basics requirement for the accessibility to disabled people and the energetic performance of buildings. It also provide directives for the territory development as well as for urban planning matter.
73	D.P.C.M. 5 dicembre 1997	This is a "framework law" establishing the acoustic requirements of sound sources within buildings and the passive acoustic requirements of buildings and their components, with the purpose of reducing human exposition to noise.
67	Decree no. 135/2004 Coll., on hygienic requirements for swimming pools, saunas and hygienic limits applying to sand at sandpits of open-air playing areas	-
66	Decree no. 137/2004 Coll., on hygienic requirements for catering services and on personal and operating hygiene principles during epidemiological serious activities	-
70	Decree no. 148/2007 Coll., on energy performance of buildings	-
65	Decree no. 410/2005 Coll., on hygienic requirements for rooms and services of enlightenment institutions for children and teenagers	-
56	Decree no. 6/2003 Coll., on hygienic limits of chemical, physical and biological indicators for indoor environment of residential rooms of some buildings	-

ID	Title	Description
55	Decree of the Ministry of Regional Developement no. 137/1998 Coll., on general technical construction requirements	-
68	Decree of the Ministry of Regional Developement no. 369/2001 Coll., on general technical requirements ensuring building use for persons with limited ability of motion and orientation	-
71	Decreto del presidente del consiglio dei ministri del 27 giugno 1986	This document is a law defining norms to be followed while building private clinics, with special attention to the elimination of architectural barriers, both without and within the structure, and to general safety issues.
50	Decreto Legislativo 19 Settembre 1994 n. 626	Regulations aimed at improving workers' safety and health within their own work environments. Among other things, the law gives directions to how the indoor built environment of workplaces should be organized in order to be safe and to facilitate safety measures.
47	Decreto Ministeriale 10 marzo 1998	A series of regulations issued in order to define some general criteria of safety in case of fire and to manage emergency situations in workplaces. The document describes procedures of fire risk assessment, as well as measures to take in order to prevent fire itself. The law has been updated in 1999.
48	Decreto Ministeriale 14 GIUGNO 1989, N. 236	The document consists of a law giving technical prescriptions to be followed in order to improve the level of accessibility, adaptability and visitability of private as well as public residential buildings, so as to remove architectural barriers.
45	Design Regulations of Swedish Board of Housing, Building and Planning,	The regulations in Chapter 6.5, "Moisture", gives requirements for avoiding bad health due to bad indoor air quality by giving requirements on mould growth in structures and what moisture levels are acceptable.
32	DIRECTIVE 2000/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of workers from risks related to exposure to biological agents at work (seventh individual directive within the meaning of Article 16(1) of Directive	This Directive aims at protecting workers from risks to their health and safety, including the prevention of such risks, arising or likely to arise from exposure to biological agents at work. To succeed that it lays down particular minimum provisions in this area
13	DIRECTIVE 2002/44/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) (sixteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)	This Directive lays down minimum requirements for the protection of workers from risks to their health and safety arising or likely to arise from exposure to mechanical vibration. Those requirements shall apply to activities in which workers are or are likely to be exposed to risks from mechanical vibration during their work.
10	Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings	The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

ID	Title	Description
6	DIRECTIVE 2003/10/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (Seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)	This directive lays down minimum requirements for the protection of workers from risks to their health and safety arising or likely to arise from exposure to noise and in particular the risk to hearing. For the purpose of this directive physical parameters used as risk predictors (peak sound pressure, daily noise exposure, weekly noise exposure level).
7	DIRECTIVE 2003/18/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of amending Council Directive 83/477/EEC on the protection of workers from the risks related to exposure to asbestos at work	This directive has been adapted to refocus and adapt protective measures for those who are now most at risk, in particular workers who remove asbestos and those who come across asbestos work in course of servicing and maintenance activities
11	Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from risks related to exposure to carcinogens or mutagens at work	This directive aims at protecting the workers against risks to their health and safety, including the prevention of such risks, arising or likely to arise from exposure to carcinogens or mutagens at work.
2	DIRECTIVE 2004/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC	The directive aims at combating air pollution and protecting citizen's health by reducing concentration in VOC in decoration colors, enamels and in products of bodywork in cars. To achieve this certain limit rates are established.
42	DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	This directive lays down certain rules in engineering industry that manufactures machineries in order to protect people and especially workers and consumers from risks arising out from use of machinery
100	EnEG 2009 - Energieeinsparungsgesetz	Aim of the guidance is that any building only used that minimum required amount of energy to achieve good level of indoor environment.
23	Energy classification of building (5282)	The regulation deals with the necessary methods needed to evaluate the energy consumption of buildings.
74	Energy Efficiency Act	The law deals with the state policy related with energy supply, energy use, energy efficiency and energy savings including as well HVAC systems
99	EnEV 2009 - Energieeinsparverordnung für Gebäude	guidance regards to energy saving for buildings (heat and energy saving technical equipment)
34	EPB Besluit	Define the basic performance in term of energy efficiency for buildings and comes from the European directive 2002/92/CE

ID	Title	Description
21	Equal Rights for Persons with Disabilities Law (1998)	Under the new law, public places and services must be made accessible, such that persons with physical, sensory, psychiatric, mental, cognitive and developmental disabilities will be able to benefit to the full from public services and will be able to enter a public place, move around and enjoy its facilities to the full. Included in the places and services which have to be made accessible are – public buildings, commercial areas, public institutions, schools, medical offices, higher education institutions, employment centers, recreational facilities, nature spots, sidewalks and junctions, foot bridges, public parks, financial services (including banking and insurance) emergency services, the common parts of residential accommodation, etc.
3	European Parliament and Council Directive 2002/95/EC on the limitation of certain dangerous subsistences in electronic equipment	The aim of the directive is to protect human's and animal's health as also to contribute to the right utilization and management of the waste of electric equipment. For this purpose electric equipment doesn't include Pb, Hg, Cd, Cr and PBB or PBDE.
41	European parliament Directive 2002/92/CE	Define the basic performance in term of energy efficiency for buildings
24	Green Building (Buildings with minimal environmental damage) standard	The standard deals with building design, building isolations, glazing, and lightning, heating and cooling
83	Health & Safety at Work, etc Act 1974	An Act to make further provision for securing the health, safety and welfare of persons at work, for protecting others against risks to health or safety in connection with the activities of persons at work, for controlling the keeping and use and preventing the unlawful acquisition, possession and use of dangerous substances, and for controlling certain emissions into the atmosphere; to make further provision with respect to the employment medical advisory service; to amend the law relating to building regulations, and the Building (Scotland) Act 1959; and for connected purposes
87	Indoor Climate and Ventilation of Buildings	Regulations for indoor climate (air quality, thermal comfort, lightning and acoustics) and ventilation of buildings (residential, offices, commercial etc.). Includes also regul. for air-tightness of and pressures in ventilation systems, and guidelines for energy performance of ventilation systems, the ventilation of parking garages and to ensure good operating and commissioning of ventilation systems
88	Instructions for healthy housing	The Ministry of Social Affairs and Health is entitled to issue, for reasons of health, instructions regarding physical, chemical and biological factors in housing and other living premises in virtue of section 32 of the Health Protection Act (763/1994). The instructions include guidelines for physical, chemical and microbiological factors affecting IAQ like temperature, humidity, ventilation, radon, noise, chemical pollutants, particles, fibers, microbes and temperature of water in buildings.

ID	Title	Description
38	Koninklijk besluit van 9 mei 1977 genomen in uitvoering van de wet van 17 juli 1975 betreffende de toegang van gehandicapten tot gebouwen toegankelijk voor het publiek	Requirement concerning the accessibility of public access buildings.
46	Law	Air changes Minimum and maximum temperature Radon content
51	Legge 5 Marzo 1990 n. 46	The document is a law concerning norms on safety of systems found in built environments, like electrical systems, heat systems, water systems, fireproof systems etc. The law gives instructions on how the aforementioned systems should be designed and assessed.
72	Legge 9 gennaio 1989 n. 13	This law provides directives specifically aimed at the removal of architectural barriers within private buildings.
1	Ministerial decision enforcing art3. of the law 3730/2008 for the protection of juveniles from alcohol and smoking	This clause enforces smoking ban in order to protect public health in all of the public and private places apart from houses, psychiatric clinics, outdoor places and enterprises with 70 square meter area maximum, that are characterized as smoking areas. While offenders are liable to prosecution.
89	Musterbauordnung	use specific requirements regards to indoor environment
90	Musterbauordnung	use specific requirements regards to residential buildings
91	Musterbauordnung	use specific requirements regards to disabled accessibility
92	Musterbauordnung	technical equipment: lift engineering
93	Musterbauordnung	technical equipment: ventilation systems
94	Musterbauordnung	technical equipment, electrical and mechanical engineering, fuel burning, heat generating
95	Musterbauordnung	means of escape routes, openings, exits
96	Musterbauordnung	specification about walls, ceilings, roofs: §26, §27, §29, §30, §31, §32
97	Musterbauordnung	general specification for construction of buildings
98	Musterbauordnung	-
40	Normes de base prévention incendie (Arrêté Royal 19/12/1997 et modification)	Fire safety regulation - requirements for buildings
54	Official announcement of Speaker RP from 17 of August 2006 - Building regulations	Act is a standardization of actions cover planning/ designing, building, maintenance and pulling down of objects and regulate principle of operation public administration in those fields
63	Order of the goverment no. 1/2008 Coll., on protection of health against non.ionizing radiation	-
59	Order of the goverment no. 101/2005 Coll., on detailed requirements for workplaces and occupational environment	-
61	Order of the goverment no. 148/2006 Coll., on protection of health against harmful effects of noise and vibrations	-

ID	Title	Description
64	Order of the government no. 361/2007 Coll., on concerning occupational health and safety	-
37	Réglement Général de la Protection au Travail / Loi sur le bien être au travail	Defines the maximum rate of exposition to physico-chemical risks as well as indicators to give the worker a good quality to their work environment
33	Réglement Régional d'Urbanisme	Define the basics requirement for the accessibility of buildings to disabled people, energy performance requirement for the buildings and also other requirement for urban planning
75	Regulation 15/28.07.2005	Technical norms and regulations for design, construction and operation of plants and equipments for generation, transmission and distribution of heat
76	Regulation 18/12.11.2004	Energy characteristics of plants and buildings
53	Regulation on the technical requirements of the buildings and their location	This document summarizes in detail technical requirements of newly build objects, the way they should be situated on the building plot and spatial development of the surrounding area. It also refers to rebuilding, superstructure, conversion and the change of the current ways of the maintenance of the existing buildings.
78	Regulation on ventilation and air conditioning of buildings	Slovenian national regulation which imposed the min. requirements for ventilation of buildings with respect to its use and gives technical requirements for design of ventilation and AC systems related to indoor air quality and energy efficiency. It defined condition for thermal comfort in the living spaces.
39	RGIE (réglement général sur les installations électriques)	Regulation concerning the requirement for electrical systems in buildings
22	The new regulations for the accessibility of new public buildings	The new regulations improve the previous regulations under the accessibility law of 1998. For example, under the new regulations of 2007, all types ((instead of some specific types) of new public buildings (including refurbishments) will need to be accessible in order to get licensing. The new regulations detail enforcement tools.
84	The Workplace (Health, Safety & Welfare) Regulations 1992	The Secretary of State, in exercise of the powers conferred on her by sections 15(1), (2), (3)(a) and (5)(b), and 82(3)(a) of, and paragraphs 1(2), 9 and 10 of Schedule 3 to, the Health and Safety at Work etc. Act 1974[1] ("the 1974 Act") and of all other powers enabling her in that behalf and for the purpose of giving effect without modifications to proposals submitted to her by the Health and Safety Commission under section 11(2)(d) of the 1974 Act after the carrying out by the said Commission of consultations in accordance with section 50(3) of that Act, hereby makes the following Regulations:—
25	UNI 11131 - Field measurements of the air humidity	The regulation set the physical parameters and the tools suitable for air humidity measure for a proper conservation of Cultural Heritage, both indoor and outdoor. The regulation provide indications to perform an accurate measure of the microclimatic environment and to study intacion between air and objects

ID	Title	Description
8	Way of measurement for the observance of the limit of safety exposure of public in electromagnetic radiation by each antenna	The aim of this decision is to protect the health of citizens of Greece from electromagnetic radiation. To succeed that Greek government applies a regulation for the measurement of the levels of electromagnetic radiation

Table 8: Overview of relevant regulations (sorted in alphabetic order by title)

3.7. Technologies

3.7.1. Survey results

There were collected in total 27 inputs in the Technologies survey. In the analysis of results structure (see Table 9) can be found share of basic six categories on the results. The mostly mentioned technologies relate to the comfort issues (48 %), whereas safety and accessibility issues inputs are missing.

Category	Category share in Technologies survey
Comfort	50 %
Energy	30 %
Health	18 %
Economic indicators for the indoor environment	3 %

Table 9: Categories shares in Technologies survey

Table 10 shows that the obtained inputs in the Technologies survey are more distributed more among office and commercial buildings than among residential and educational buildings. From other categorized building types are mentioned hospitals, museums, industrial buildings. Five of all 95 regulations are applicable for any building type without restriction.

Building type	Number of applicable standards
All building types without restriction	5
Office buildings	20
Commercial buildings	19
Residential buildings	15
Educational buildings	15
Other occupancy types	
Hospitals	2
Museums	1
Industry	1
transportation	1

Table 10: Obtained Technologies survey inputs and building types applicable

3.7.2. List of relevant technologies

ID	Title	Description
4	Absorption chiller	An absorption chiller is a system which recovers thermal energy and transforms it in chilling energy. In civil application it is often coupled with a cogenerator. Through a proper thermodynamic cycle. The energy is absorbed from the external reducing the amount of heat in the environment.
13	Air conomy	multi function (heating, cooling, ventilation), efficient indoor climate
10	Concrete core activation	complex pipe system for cooling effect, high store capacity, problematic dullness effects and capacity dullness

ID	Title	Description
1	Electro-magnetic field measurement kit	A system that measures the three spatial components of the electro-magnetic field in a specific point. It can be equipped with different sensors, depending on the frequency of the field to measure.
17	Enhancing Natural Light	More natural light should be secure through the roof. Intelligent light-gathering systems. Avoiding overheating effects.
8	Heating and cooling ceiling	Capillary tube in the ceiling for heating and cooling effects
9	Heating and cooling walls	heating and cooling of walls, indoor comfort,
3	CHP system	It's a system that allows the combined generation of electro-mechanical power and heat energy. CHP system can be fed by natural gas or fuel. The energy is generated through internal combustion engine or turbogas.
16	Individually controlled micro-environment	Individually controlled environment at workplaces will provide occupants with preferred micro-environment at their workplaces and thus will increase their satisfaction and will improve their work performance. The implementation of individually controlled technologies in buildings has potential for tremendous energy saving. This technology needs to be further developed and applied in practice.
23	Innovative energy saving windows	Constructional and functional innovative wood frame windows and wood-aluminium frame windows. They contain 2-4 low emission panes with space between pasen filled with argon.
21	Integrated Workplace Management System	A single application software suite known as an Integrated Workplace Management System provides the critical tools and technologies necessary to manage the entire real estate lifecycle for improved operational, financial and environmental performance. IWMS brings together the disciplines of real estate, construction/project management, facility management, maintenance operations, and environmental sustainability into a single web-based technology platform.
25	K-LUCE	This technology consists of a system that embeds lights, to be used in interior environments, directly within ceilings and walls of the environment itself, so that light is diffused by them. Its purpose is to improve comfort of the indoor built environment through an aesthetically pleasant solution.
24	Mechanical ventilation system with heat recovery	High-efficient mechanical ventilation system with heat recovery, using circulation air in duplex-system. Use in single family houses, in dwellings. Low-energy and passive house level. Better moisture control in winter
11	peripheral acclimatization	comparison of central and peripheral acclimatization, construction, build, energy costs, control, maintenance
12	peripheral ventilation	peripheral air heating system, concept: "Save Energy"

ID	Title	Description
5	Photovoltaic system	A photovoltaic system collects solar radiation and transforms it in electricity. It's typically coupled with an inverter to feed alternating current loads. Depending on the specific installation, it can be connected to the power grid or to a battery system.
2	Platform CREA	An innovative platform that connects through wireless links a wide range of commercially available sensors (all the sensors compliant to the 4-20mA and 0-10V standards), in order to perform a pervasive indoor monitoring. Data is collected and transmitted to a remote control centre for storage and future analysis
18	Preheated/precooled air through underground pipes	The ventilation inlet should be driven through underground pipe to secure preheated/cooled air.
19	Real Time monitoring System	SensiNet® is a complete, wireless sensor network built for industrial and commercial environments where wireless operation and high reliability are required. SensiNet Smart Sensors are the heart of SensiNet's flexibility. They provide a range of industry standard interfaces: 4-20 mA, 0-10 V, RTD temperature, contact closure, touch, integrated Temperature and humidity.
20	Real Time Monitoring System	The testo Saveris measurement system measures temperature and humidity values in the environment and in processes. The easy-to-use measurement system delivers safety and time savings thanks to automated measurement data recording.
14	Refresh	ventilation concept, heat recovery system, low energy losses, perfect for retrofitting
26	Sanivite	The product is a domestic waste pump that can be used to dump hot and soaped waters, produced in the kitchen. It is portable, so it allows the creation of the kitchen in different rooms of the living place, increasing the comfort of this latter.
28	Simulation of moisture and microbial problems in building	The indoor air simulator can be used to investigate how complete structures affect the indoor air quality. The simulator has several different applications, the migration studies of microbes being one of them
22	Software Platform for e-Management Solution	Leonardo is a software platform to quickly build web-based solution for managing in real-time complex infrastructures such as telecom networks, security systems and building's technical installations. Leonardo-based applications offer an intuitive easy to work environment and powerful customization features to adapt the system to the corporate operational needs. Leonardo is the ideal tool for integrators to deploy highly competitive and unique solutions in a short time to market and limited development efforts.
7	Under floor ceiling and under floor cooling	Use of under floor heating as cooling

ID	Title	Description
15	ventilation and air distribution	Present ventilation methods are based on total volume air distribution which is inefficient because clean air is supplied far from occupants and is warm and polluted by the time it is inhaled. Personalized ventilation aims to supply clean and cool air to each workplace and thus to provide efficiently optimal thermal comfort and high quality of inhaled air leading to improved health, comfort and performance of occupants at reduced energy use. Furthermore personalized flow of clean air will protect occupants and will decrease the risk of cross-infection in offices, schools, hospitals and crowded places (vehicles, concert halls, theaters, etc.).
27	Visqueen - High Performance Radon Barrier	Visqueen High Performance Radon Membrane is an LDPE un-reinforced membrane. Visqueen High Performance Radon Membrane™ is suitable for use in concrete floors not subject to hydrostatic pressure, in accordance with the relevant clauses of IS 325:Part 2:1995 and of BS CP 102:1973 Code of Practice for protection of buildings against water from the ground. The product can be installed as an over-site membrane; either between a sand blinded hardcore (50mm of sand minimum) bed and the base concrete or layered on top of high-density insulation (25kg /m3) with a concrete screed layered over it.

Table 11: Overview of relevant technologies (sorted in alphabetic order by title)

3.8. Research

3.8.1. Survey results

Collecting all the ongoing as well as finished research projects and publications that have been adopted all over the world isn't considered to be an easy case, but the effort that has been done through research surveys in PERFECTION shows the general direction that most of the organizations follow on issues such as comfort, health, safety, and also accessibility and sustainability in buildings.

R&D that has been noted done was done in universities (Blekinge Institute of Technology, University of Reading, Technical University Denmark, University of applied Sciences in Vorarlberg, Charles University in Prague, Czech Technical University in Prague, Polytechnic of Milan, Technical University of Sofia, University College Dublin), in organization for standards and technologies (National Institute of Standards and Technology), in organization specialized in environmental issues (United States Enviromental Protection Agency), laboratories that are part of national laboratory system (LBNL), in international organization that is specialized in Heating, Refrigerating, and Air-Conditioning engineering (ASHRAE), in non-profit organizations (ÉMI, Siti, ASTM, E2B European Initiative), in several types of insitutes and research centres (Belgian Building Research Institute, Construction Technologies Institute Italian National Research Council, Innovation Center Iceland, Institute of Chemical Process Fundamentals of the ASCR, Technical Research Centre of Finland) and in Ministry of Health of the Czech Republic.

Research results deal with many issues but contaminant, comfort and energy issues seem to have a remarkable place in research fields.

People appear to have a slew of healthy problems due to exposure to contaminants, to deal with this problem researchers have done extended researches. A significant result of such a research is a set of guidelines that had been adopted from ASTM and determines VOCs emission rates over a period of time under environmental and product usage. Researchers have also concluded that use of gypsum-zeolite-plates can reduce concentration of specific indoor air contaminant. Another issue is the big quantities of dust that carpet floors provide, to deal with that the use of clean floor materials is recommended as it results in higher contamination of respirable dust compared to carpet floors. Characterization of indoor air pollution and how it is influenced by different activities (such as smoking) and a comparison with outdoor air pollution has been the result of Czech researches, this characterization provides people a more plain view of what activities harm their health. Another similar to this research has been done to evaluate the dynamics of aerosol particles in indoor environment. Another Czech research that isn't totally focused on indoor pollutants has been produced in Prague, the result of which, include a list of selected components of indoor environment and pollutants which influence indoor air quality, while another part of it concerns regulation of indoor environment for Czech Republic and foreign countries and possibilities of indoor air quality assessment. Finally, a Finnish project deals with contamination in air handling systems by investigating where contamination occurs and how to prevent it and ensuring cleanliness of air handling systems. Also, a method to determine the cleanliness of the ducts by visual inspection is presented.

Apart from healthy issues like those mentioned above comfort and energy issues play also a major role and sometimes are connected one another. An example of connection between comfort and energy is latent heat accumulator which can accumulate energy in the form of stored latent heat in a fused medium and reversibly release heat on crystallization of the storage medium. The energy stored in this way can be used for either cooling or heating purposes. This type of accumulator provides increase of energy accumulation, protection of summer peak time heating, increased comfort and energy savings. Another similar research is that of tempering active and passive of steel ceiling system, by this summer peak time heating will be influenced positively and will result in low energy consumption and in low costs. Innovative approaches for residential buildings that provide low heating energy requirements and mechanical ventilation adjusted to daily demands are air flow regulation and window opening positions. Researchers in CTU have been dealt with the development of HVAC (heating, ventilating and air-conditioning) equipment for microclimate creation and protection in residential and commercial buildings by improving providing pollution control, noise and vibration control, development of simulation methods for HVAC equipment operation with focus on energy efficient improvement of indoor comfort in intelligent buildings. Trying to solve the problem of airtight buildings with mechanical ventilation an Hungary organization provided a breathing building envelope that secures decent indoor air quality and energy savings without mechanical ventilation.

Energy is an endless issue in scientific community and apart from the programs mentioned above some other programs for energy in building have been noted down. An important program tends to provide the measurement science that will enable the development of Net-Zero Energy Buildings while providing a healthy, productive, and safe indoor environment. Another one develops and verifies an Integrated Simulation System (ISS) for optimization of buildings' energy performance and indoor environment. While E2B EI plays an important role by delivering, implementing and optimizing building and district concepts that have the technical, economic and societal potential to drastically decrease the energy consumption and

reduce CO2 emissions due to existing and new buildings at the overall scale of the European Union. The main purpose of it is to reach the goals set forth for 2020 and 2050 to address climate change issues and contribute to improve EU energy independence thereby transforming these challenges into a business opportunity.

Accessibility of disabled and elderly people is also a major issue as most of the buildings don't have provisions for disabled making accessibility and facilities in buildings difficult to reach, two projects have been noted to deal with this. The first of them is an extensive research and practitioner network related to the needs of elderly (and disabled) people in the UK. The network holds regular events and focuses on information sharing and development of research. While the subject of the other is to develop a model to evaluate the evacuation of disabled people (looking at the accessibility problem) in hotels and restaurants in case of fire as well as an assessment of the fire security.

Noise control has also been issued in a project dealing with room acoustic and passive climatisation interaction between room acoustic and passive climatisation that results in possible solutions for conference room. Specified research has also been done for hotels and offices concerning new indoor concepts, building products and technical installations with focus on health and maintenance and solutions for acoustic performance of ceilings. To provide comfort to residential a R&D project deals with supporting the integration of home automation systems within the domestic environment. The main objective of the project is to conduct research activities in order to assure a functional integration of domotic systems in order for them to be easily usable. There is also a project that includes all of the indicators and focuses on reducing the energy used for thermally conditioning and distributing ventilation air in buildings, improving indoor air quality (IAQ), thermal comfort and the health and productivity of building occupants, and understanding human exposures to environmental pollutants found in indoor and outdoor air. Achieving comfortable and preferred environment for each occupant leading to increased work performance, satisfaction and quality of life has been also issued in another program.

What is considered to be really useful is the tools and the guides that have been adopted to provide adequate design to buildings in order to provide indoor environmental quality integrated within a sustainable building. One of them is a tool that is specialized in schools and is used to be designed schools with priorities, such as energy efficiency, indoor air quality, day-lighting, materials efficiency, and safety, and doing so in the context of tight budgets and limited staff. Another guidance tool designed for use by building professionals and others interested in indoor air quality in commercial buildings is I-BEAM, this tool contains forcontains text, animation/visual, and interactive/calculation and components that can be used to perform a number of diverse tasks. A technically similar tool but with focus on selecting cost-effective, environmentally-preferable building products is Bees. DOCET is also a software simulation tool for the energy certification of existing residential buildings and apartments, developed on the basis of CEN methodologies. Another one that intends to inform the public regarding applicable, economical ways to lower energy needs in homes and offices is “Energy requirements” which evaluates energy requirements for buildings; both measurement and calculation (modelling). Apart from that tools there are also guidance documents, which aren't of course as practical and flexible as the tools mentioned above but they have a great utility too. Those are: Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning with focus on air quality and Guidebook for life-cycle commissioning of buildings energy with focus on energy efficiency and indoor climate.

More specified programs are a project that maps housing conditions in Scandinavia and Bulgaria regarding indoor environments and its associations to allergies, airways infections and SBS and another one for Irish houses with similar subject.

Considering that the filling surveys process hasn't been carried out to a great extent we can't really make strong verdicts but an obvious gap in positive stimulation and accessibility can be easily identified.

3.8.2. List of relevant research

ID	Title	Description
44	A study on the relation between allergy/asthma and indoor air quality in homes in Bulgaria, 2003-2005	Mapping housing conditions in Scandinavia and Bulgaria regarding indoor environments and its associations to allergies, airways infections and SBS.
2	Active Noise Control in Ventilation Systems	This research is focused on applying active noise control technique to noise generated in ventilation systems.
20	Aktive und passive Temperierung eines Stahldeckensystems	active and passive tempering of steel ceiling system, use of PCM and passive ceiling system and their interaction with indoor temperature behaviour, measuring in testing facilities and numerical calculations
3	ASTM D6670 - 01(2007) Standard Practice for Full -Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products	This practice provides guidelines for using a full-scale environmental chamber for testing large materials and full-scale material systems/assemblies. Specifically it determines VOCs emission rates over a period of time under environmental and product usage conditions that are typical of those found in office and residential buildings.
12	Bauprodukte: Schadstoffe und Gerüche bestimmen und vermeiden. Ergebnisse aus einem Forschungsbericht	Building Products: Contamination and smell collected and avoided.
21	Bedarfsgerechtes Lüften - Volumenstromregelung und Fensteröffnungszustand	adjusted ventilation to the needs - air flow regulation and window opening positions, two innovative approaches for mechanical ventilation for residential buildings, theory into praxis analysis of buildings over three years
6	BEES (Building for Environmental and Economic Sustainability) software	Bees is a software that brings a powerful technique for selecting cost-effective, environmentally-preferable building products. The tool is based on consensus standards and designed to be practical, flexible, and transparent.
25	Breathing building envelope	We are design nowadays high airtight buildings with mechanical ventilation. Other alternative could be intelligent "Breathing" structure mainly for lightweight construction.
28	Collectief onderzoek - Ontwikkeling van model voor de evaluatie van de toegankelijkheid, brandveiligheid en evacuatie voor personenen met beperkingen in de Horeca	This project aims to develop a model to evaluate the evacuation of disabled people (looking at the accessibility problem) in hotels and restaurants in case of fire.
19	Der Latentwärmespeicherestrich	The latent heat accumulator pavement Simulations of specific use of latent heat accumulator pavement and the interaction with the indoor climate

ID	Title	Description
47	DOCET	DOCET is a software simulation tool for the energy certification of existing residential buildings and apartments, developed on the basis of CEN methodologies. The tool is characterized by easiness of data input and repeatability of analyses, while keeping accuracy of results.
29	Energy requirements	Evaluation of energy requirements for buildings; both measurement and calculation (modeling)
48	Ensuring cleanliness of air handling systems	The project investigated where contamination occurs in air handling units and how to prevent them. Also, a method to determine the cleanliness of the ducts by visual inspection is presented
17	Feinstaub im Innenraum - ein unterschätzes problem	Indoor contamination of respirable dust - an underestimated problem Research of respirable dust contamination in indoor environments regards to fittings and use
46	Field Investigation of Ventilation Performance and Indoor Air Quality in Typical Irish Dwellings	In this Ph.D. thesis the indoor environment of typical Irish houses are analyzed with a combination of field measurement, questionnaire survey, full-scale in-house experiment and statistical analysis.
15	Gips-Zeolith-Platten zur Verbesserung der Innenraumluftqualität Teil 1	Gypsum-zeolite-plates for improvement of indoor quality development of new building products e.g. gypsum based plates with calcium-sulphate-dihydrate-clinoptilolith production, basis of building physical phenomena
16	Gips-Zeolith-Platten zur Verbesserung der Innenraumluftqualität Teil 2	development of new gypsum plates (e.g. based on calcium-sulphaste-dihydrate-clinoptilolith, determination of contaminant absorption in laboratory and real buildings
51	Guidebook for life-cycle commissioning of buildings energy	In the guidebook (in Finnish) general procedure for ToVa activities is described covering the whole life cycle of the building. ToVa means clear definition, capturing and documentation of end user requirements and their compliance assessment and verification in all the phases from design through realization to the operation and use. In the guidebook special focus has been put on the indoor air quality and energy efficiency.
8	Healthy and Sustainable Buildings Program	The goal of this Program is to provide the measurement science that will enable the development, deployment, and use of building energy technologies that will move the Nation towards Net-Zero Energy Buildings while providing a healthy, productive, and safe indoor environment.
5	IAQ Building Education and Assessment Model (I-BEAM)	I-BEAM is a guidance tool designed for use by building professionals and others interested in indoor air quality in commercial buildings. I-BEAM contains text, animation/visual, and interactive/calculation components that can be used to perform a number of diverse tasks.
4	IAQ Design Tools for Schools	IAQ Design Tools for Schools provides both detailed guidance as well as links to other information resources to help design new schools as well as repair, renovate and maintain existing facilities.

ID	Title	Description
10	Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning	This project started in November 2006 and the document is expected to be developed over a 36 month (3 year) time line. The final result will be the Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning for commercial and institutional buildings along with an educational outreach effort.
24	Indoor Climate	Design of uniform environment for an "average" person has been in the basics of the indoor climate research. However, since requirements of people are different this strategy has not potential to provide each occupant with preferred environment. Human response to n0n-uniform individually controlled environment needs to be studied and applied in practice.
9	Indoor Environment Research	The Indoor Environment Department conducts a broad program of research, technology development and dissemination activities directed toward improving the health, comfort and energy efficiency of the indoor environment. Our work focuses on reducing the energy used for thermally conditioning and distributing ventilation air in buildings, improving indoor air quality (IAQ), thermal comfort and the health and productivity of building occupants, and understanding human exposures to environmental pollutants found in indoor and outdoor air.
33	Institutional research plan MSM 210000011	Environmental Engineering of Buildings. HVAC (heating, ventilating and air-conditioning) equipment for microclimate creation and protection, air pollution control, noise and vibration control, development of simulation methods for HVAC equipment operation, renewable energy sources, equipment for intelligent buildings. Indoor and outdoor air pollution control, airflow in ventilated space, indoor dust contamination. Aerodynamic sources of noise in air-conditioning devices, noise attenuators for ventilating and burning equipment, control of noise radiated from HVAC equipment into outdoor and indoor environment. Development of HVAC equipment for microclimate creation and protection in residential and commercial buildings from the hygienic and safety point of view with focus on energy efficient improvement of indoor comfort in intelligent buildings.
34	Institutional research plan MSM6840770005	This project has paid a special attention to protective barriers – thermal and noise insulating, or anti-radon for housing development, respectively, or more precisely, to the barriers on the base of clay minerals used against the spreading of contamination from various landfills, waste dumps, sedimentations basins, disposal sites, including high level radioactive waste materials. The common point of view for engineering structure has been the process EIA- an assessment of the impact of constructions on the environment.
45	Integrated Design Optimization of building energy performance and indoor environment	Development and verification of an Integrated Simulation System (ISS) for optimization of buildings' energy performance and indoor environment.

ID	Title	Description
27	Integrated Platform	An innovative platform that connects through wireless links a wide range of commercially available sensors (all the sensors compliant to the 4-20mA and 0-10V standards), in order to perform a pervasive indoor monitoring. Data is collected and transmitted to a remote control centre for storage and future analysis
22	Komfort der Zukunft - "inhaus2" in Duisburg	comfort for the future - "inhaus2" in Duisburg, new indoor concepts, building products and technical installations for offices and hotels, focus on health and maintenance, solutions for acoustic performance of ceilings
41	L'ambiente domestico informatizzato: progetto e verifica di integrazione di utente, tecnologia e prodotto	This R&D project, approved within an Italian national financing programme (PRIN), aims at supporting the integration of home automation systems within the domestic environment. The main objective of the project is to conduct research activities in order to assure a functional integration of domestic systems in order for them to be easily usable.
52	LENSE	The main objective of LEnSE was to develop a methodology for the assessment of the sustainability performance of existing, new and renovated buildings, which is broadly accepted by the European stakeholders involved in sustainable construction.
43	E2B EI	The overall objective of E2B EI is to deliver, implement and optimize building and district concepts that have the technical, economic and societal potential to drastically decrease the energy consumption and reduce CO2 emissions due to existing and new buildings at the overall scale of the European Union.
18	Optimierung der Lufstromrate in Geäbuden	Optimization of air flow rate in buildings. Optimization of air flow rate in buildings regards to overall costs, indoor climate, health and efficiency
26	Prof. (FH) Dr.-Ing.	We are working in the area of Living Lab.
30	Project 2B08077	Characterization of air pollution sources in indoor environment
32	Project GA101/07/1361	Evaluation of dynamics of aerosol particles in indoor environment
31	Project NJ5907	Characterization of Indoor Air Pollution of Residential House Influenced by Different Activities. Comparison with Outdoor Air Pollution.
13	Raumakustik und passive Klimatisierung	room acoustic and passive acclimatization interaction between room acoustic and passive acclimatization, acoustic indoor quality, user specific room acoustic design, possible solutions
14	Raumakustisches Monitoring in passiv klimatisierten und bauteilaktivierten Geäbuden	Room acoustic monitoring in passiv climatisated buildings. Research of buildings with passiv cooling.
23	Raumkühlung mit Latentwärmespeicher	Indoor cooling with latent heat accumulator, use of latent heat accumulator, choice of phase materials, cooling system, experimental studies

ID	Title	Description
49	Reference values for building material emissions and indoor air quality in residential buildings	The project studied IAQ and material emissions in newly finished residential buildings and during the first year of occupancy. Low emitting, M1 classified materials were used on all surfaces. Based on the results, reference values were presented for 6- and 12 month old buildings
39	Result of RIV/68407700:21110/05:01109482	Indoor pollutant concentration is more significant for human health than outdoor atmosphere because people spend most of their time in buildings. There is pollutant concentration enhancement, relative humidity, mould reproduction and rise of environment not corresponding to human organism needs because of insufficient ventilation. Overview of selected indoor environment components and pollutants is stated in this paper.
40	Result of RIV/68407700:21110/06:01117540	Interior microclimate formation performs required indoor environment formation. List of selected components of indoor environment and pollutants which influence indoor air quality. Regulation of indoor environment for Czech Republic and foreign countries, possibilities of indoor air quality assessment.
37	Result of RIV/75010330:_____/05:00006227	Requirements for clean spaces in hospitals and the ways of their verification
38	Result of RIV/75010330:_____/06:00006742	Intervention in the indoor environment. The indoor air contaminants concentration is always higher than this in outdoor. The steps for improvement of the indoor environment quality.
35	Result RIV/75010330:_____/03:00005115	Microclimatic parameters of the indoor environment in buildings in the course of extreme temperatures of the outdoor air
50	Semi volatile organic compounds and flame retardants. Occurrence in indoor environments and risk assessment for indoor exposure	The project investigated the occurrence of semi volatile compounds, SVOCs incl. flame retardants in indoor environments in Finland. SVOC emissions from 13 typical building products were measured
11	SPARC	Extensive research and practitioner network related to the needs of elderly (and disabled) people in the UK. The network holds regular events and focuses on information sharing and development of research.
42	Spazi e arredi delle residenze per anziani, disabili e senza casa	The main purpose of this R&D project is to define experimental solutions in the building and interior decoration field that, while contrasting the loss of autonomy and integration of individuals in different living contexts, can function as reliable examples on the socioeconomic, technical and cultural levels, in order to correct the perduring inadequacy of the residential offer.
36	Výsledek RIV/75010330:_____/03:00005361	Hospital indoor environment: Screening for microorganisms and particulate matter (2003)

Table 12: Overview of relevant research (sorted in alphabetic order by title)

3.9. Policies

3.9.1. Survey results

In policy surveys results, the first thing we notice is that there aren't many countries in the EU that have policies to guide actions on indoor environmental quality integrated within a sustainable, low-energy built environment.

Finland seems to apply the most policies relatively to the other EU countries, having organizations that are specialized in buildings and indoor air and climate. Corresponding organizations act in other countries too, such as institution of building services engineers in UK, German sustainable building council in Germany, State fund for housing development in Czech Republic, while in Israel a ministry of infrastructures seems to exist.

From a total of 28 policy actions only 3 of them have compulsory enforcement and those refer to health issues in building services in UK, effective functioning of energy sources in Republic of Bulgaria and energy conservation in Israel.

A great number of policies that have been noted down and are applied in EU countries and Israel focus on energy savings. Those are energy savings policies that are applied in Israel and support market transformation activities that target on creating public awareness in energy conservation as also by supporting energy consumers, energy saving policies that are applied through financial support and through the support of energy conservation systems in Czech Republic and by effective functioning of energy sector in Bulgaria. Generally speaking, apart from energy issues policies that have been noted down, adopted policies differ. United Kingdom's institution of building services engineers has lined certain health issues in building services. Sweden lined how regulations in moisture should be understood and used. Hungary lined an action plan for the visual comfort. Greece has laid down some directions helpful for the accessibility of disabled. Finland has classified indoor climate and created guidance and assessment methodology for design stage & post construction to be built moisture resistant building structures and high indoor climate quality (incl. air quality, thermal comfort, lightning, structure humidity).

3.9.2. State of the art and emerging trends

Considering that policies are supposed to guide decisions, the policies that have been written down aren't very satisfying. Not all EU countries seem to have specified organizations in building issues focused on policy making, which results in little existence of policies. In some cases, this gap is covered by regulations, which isn't considered as a problem, but most of the times this isn't the case. The establishment of this such type of organizations would contribute in adoption of policies that would include indicators that have been listed in the surveys. What isn't listed in the surveys and it's a matter of policy is positive stimulation in buildings. Children, disabled people, elder, patients in hospitals are all included in sensitive population and buildings in which those people live should have certain provisions to make the indoor environment pleasant and not boring or non accessible. The rest of the indicators should also drive in adopted policies but till now there haven't been many efforts at this direction.

3.9.3. List of relevant policies

ID	Title	Description
6	Absorption of the performance contracting method in energy service projects	The Ministry of National Infrastructures is implanting and encouraging various methods for carrying out projects for making energy consumption more efficient. The level of the Ministry's support relates to the degree.
13	Action Plan	We are spent most of our time in indoor environment, especially the young and the elder generation. There should be more strategic view and action to secure its necessary quality.
11	CIBSE TM40: 2006	Health issues in building services
15	Classification of Indoor Climate 2000.	Defines different classifications of the indoor climate. Classification based on performance indicators and related design and target values for that. Also construction requirements are included
28	Criteria for Healthy Buildings, dwellings	The guidance includes criteria/instructions for the design& realization of moisture resistant building structures and high indoor climate quality (incl.air quality, thermal comfort, lightning, structure humidity)
29	Criteria for Healthy Buildings, offices	The guidance includes criteria/instructions for the design& realization of moisture resistant building structures and high indoor climate quality (incl.air quality, thermal comfort, lightning, structure humidity)
10	Design directions for the independent movement and living of disabled	Those directions aim at being taken into account accessibility for disabled when buildings are designed. It provides directions for the design of outdoor places (i.e. sidewalks), ramps, stairs, and elevators, building entrances, toilets and buildings in general.
25	encourage energy conservation -Market transformation activities	Market transformation activities – Creating public awareness of the need to conserve energy when purchasing energy consuming products – residential or industrial. Inclusion of the energy conservation element as an important consideration when decisions are made regarding the purchase of an energy consuming appliance or energy consuming equipment.
5	Energy conservation in buildings	The Ministry of National Infrastructures accompanies and supports specific energy consumers in order to make energy use more efficient in these consumers' equipment or buildings.
24	Energy strategy of Republic of Bulgaria	Effective functioning of energy sector of Republic of Bulgaria
23	Financial support for environmentally saving methods of heating and/or water heating for flats and family houses of individuals	Support of biomass boilers, solar systems for water heating and heat pumps
20	German Sustainable Building Certificate	- voluntary certification system for sustainable buildings - version 2008 is available for office and administration buildings - version 2009 is under development

ID	Title	Description
17	Gezondheidskaart (Health Card - in Dutch)	Assessment methodology to determine health quality for existing and new dwelling. Assessment is based on objective criteria, applying checklists and if possible through measurements. Assessment should be done within one day.
21	Green Light for Savings	Financial support for energy savings and production of heat from renewable energy sources in Czech households that will lead to a significant reduction in greenhouse gas emissions, as well as air pollution. Financial support comes from selling emission credits.
14	Health Optimization Protocol for Energy-efficient Buildings	Assessment methodology for assessing health of apartment dwellings and office buildings
30	Indoor climate classification 2008. Target values for indoor climate, design instructions and product criteria.	Target values for indoor climate, design instructions and product criteria. The 3rd version of it was published in 2008.
9	Lifetime Homes Standards	This standard has been created to assist housing provider and designers in meeting the needs of people over their whole life. It includes 16 standards (or recommendations) related to access and facilities in buildings. The standards are supported by some guidance and have been adopted by some housing agencies in the UK as a requirement for public funding.
7	Participation in micro-projects	Support for the efficient use of energy sources without affecting economic activity and without reducing the standard of living.
16	Performance criteria of buildings for health and comfort	Definition of healthy building with descriptive guidelines how to reach target values for identified performance indicators.
12	Professor	Describes how the regulations from the Swedish national board of Housing, Building and Planning – Boverket - on moisture should be understood and used
22	Program PANEL	Financial support for reconstructions, modernizing and regeneration of residential buildings constructed by building panel technology.
27	PromisE environmental classification for buildings	The Promise scheme for new& existing buildings includes "Health of occupants", which includes management of indoor climate, indoor air quality, and management of moisture damage. Following parameters included: ventilation, supply air quality, emission from materials, control of humidity, radon, thermal comfort, sound-acoustics. Assessment methodology for design stage & post construction. Classes A-E
18	Toets-/verbeterinstrument gezondheid woningen (TGW)	Assessment methodology to determine health quality for existing dwellings. Assessment is based on objective criteria, applying checklists.
19	Toetslijst Gezond en Veilig Wonen – Consumentenversie	Assessment methodology to determine possible exposure to healths in existing dwellings. The assessment combines building characteristics and households that are living in the dwelling.

Table 13: Overview of relevant policy (sorted in alphabetic order by title)

REFERENCES

[1] Council directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, Official Journal L 330 , p. 32 – 54, 1998
[2]DIRECTIVE 2002/91/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2002 on the energy performance of buildings, Official Journal L1, p. 65-71, 2003

ANNEX 1 – FILLED QUESTIONNAIRES ON STANDARDS

ANNEX 2 – FILLED QUESTIONNAIRES ON REGULAITONS

ANNEX 3 – FILLED QUESTIONNAIRES ON TECHNOLOGIES

ANNEX 4 – FILLED QUESTIONNAIRES ON RESEARCH

ANNEX 5 – FILLED QUESTIONNAIRES ON POLICY