

PERFECTION – Performance Indicators for Health, Comfort
and Safety of the Indoor Environment
FP7 Grant Number 212998

Indicator Toolbox

Federico Stirano¹ Roberta Sabbatelli² Janne Porkka³ Aapo Huovila⁴ Nikos Sakkas⁵ Maria Niktari⁶

Version	Description	Date
0.1	Draft for Comments	24/11/09
1.0	Final Draft Version for comments	22/07/10
01/02/00	Final version	30/07/10

Deliverable 2.2.

Dissemination: Task partners only

¹ SIT – Istituto Superiore sui Sistemi Territoriali per l’Innovazione – via Pier Carlo Boggio, 61 – 10138 Torino – Italy – federico.stirano@siti.polito.it

² SIT – Istituto Superiore sui Sistemi Territoriali per l’Innovazione – via Pier Carlo Boggio, 61 – 10138 Torino – Italy – roberta.sabbatelli@siti.polito.it

³ VTT Technical Research Centre of Finland, Finland – janne.porkka@vtt.fi

⁴ VTT Technical Research Centre of Finland, Finland – aapo.huovila@vtt.fi

⁵ APINTECH, Construction Services Support Unit, Greece – sakkas@apintech.com

⁶ APINTECH, Construction Services Support Unit, Greece – niktari@apintech.com

Table of Content

1. INTRODUCTION.....	3
2. INDICATOR FRAMEWORK.....	4
2.1. Health and Comfort.....	5
2.2. Feeling of safety and Positive Stimulation.....	8
2.3. Accessibility and Functionality.....	10
2.4. Application in Building Types.....	12
2.5. Sustainability Impact.....	12
2.6. Building Reference.....	14
2.7. Indicator Weight.....	14
2.8. Building Type Impact Matrix.....	17
3. TOOLBOX DESCRIPTION.....	18
3.1. General Information.....	18
3.1.1. Location.....	19
3.1.2. Project Participants.....	19
3.1.3. Site.....	19
3.1.4. Building.....	19
3.2. Indicator Evaluation.....	20
3.3. Indicator Assessment Tool.....	22
3.3.1. Weights.....	22
3.3.2. Indoor sustainability impacts.....	22
3.3.3. KIPI score.....	26
3.3.4. Indoor sustainability rating.....	26
4. PRODUCT EVALUATION.....	27
4.1. Introduction.....	27
4.2. Product provider.....	27
4.2.1. Provider registration.....	27
4.2.2. IEQ product information upload (Not accredited section).....	27
4.2.3. IEQ product information upload (Accredited section).....	28
4.3. Product buyer.....	29
4.4. Other tool implementation details.....	29
4.4.1. User support.....	29
4.4.2. Charges.....	30
4.4.3. Property rights.....	30
5. CONCLUSION.....	31

1. INTRODUCTION

This document aims at defining a toolbox for the evaluation of the performance indicators identified in the WP 1. The tool will take into account both the **building evaluation aspect** and the **product impacts** on the model. The **indicators' list** that will be included in the toolbox is derived from the indicator framework developed in **T1.5**.

The toolbox will fully illustrate all the details needed to calculate the different indicators and the relevant significance of each of them. Assigning proper weights to the various indicators, it will be possible to compute a building evaluation mark.

The document will also introduce some detail of the implementation of the section related to the product evaluation, with regards to the defined indicator framework.

2. INDICATOR FRAMEWORK

The proposed Key Indoor Performance Indicator (KIPI) framework in PERFECTION is structured in a hierarchical way. The outline of the framework is shown in Table 1.

Table 1: PERFECTION Indicator Framework

	Name	Description	
Heath and Comfort	Indoor Air Quality	1 Effective Temperature	Temperature [°C] and relative humidity [%RH] are combined into one indicator called effective temperature.
		2 Effective Ventilation / CO2	The effective ventilation of a space is characterized by the carbon dioxide (CO2) concentration in a room.
		3 Combustion Sources / Infiltration	Carbon monoxide is an appropriate air quality measure because of the significance of the health effects and associated risk and liability of this contaminant.
		4 Odour Intensity	The judgment of odours is a valuable tool for diagnosing potential indoor air quality problems.
		5 Particle Matter Concentration	Particulates (P < 2.5µg/m3) are defined as suspended mixtures of solid or liquid particles.
	Quality of drinking water and reuse water	6 Drinking water quality	The availability quality of drinking water in a building is mainly determined by the definition and the implementation of a water safety plan.
		7 Rain/re-use water quality	The quality of grey and rain water in a building is mainly determined by the definition and the implementation of a water safety plan.
	Thermal Comfort	8 Operative Temperature	The operative temperature inside a building, depending on the different activities that are performed.
	Visual Comfort	9 Illuminance	A satisfactory visual performance is a sufficient illuminance for the specific visual tasks which are carried out in the room.
		10 Daylight Factor	The daylight factor is the ratio of the illuminance from the skylight inside the building with the illuminance from the skylight on the same surface with an unobstructed access to the sky.
	Acoustic Comfort	11 Background noise level	The background noise level represents the average noise level over 30 minutes.
		12 Reverberation Time	The reverberation time reflects the presence of echoes with a relevant impact on communication between people
Feeling of Safety and Positive Stimulation	Safety	1 Safety in use	Safety issues linked to five categories of risks: glazing, slips, trips and falls, entrapment and falling objects.
		2 Feeling of safety	Human feeling of safety
		3 Meeting current regulations	Check if regulations linked to fire, structural, electrical, magnetic fields, non ionizing radiations and radioactivity have been respected
	Security	5 Cultural heritage protection	Suitability of the indoor environment to host artworks, analyzing physical and chemical parameters and use of equipments to prevent objects degradation.
		6 Personal and material security	This indicator checks if adequate protection measure are taken against criminality toward people and objects.
		7 Security of Information	Evaluating of the security of information, by analyzing the compliancy with international standards related to the management of sensible data.
		4 Safety against terrorism	Check if opportune countermeasures are taken to prevent damages from terrorist attacks
	Positive Stimulation	8 View to outside	Evaluation of an average view to outside from the perspective of focal spaces in the building.
		9 Architectural Design	Evaluation of the aesthetic quality of the building based on the judgement of space solutions, spatial relations and forms and quality impression of fittings and surfaces.
		10 Visual Stimulation	Information about visual positive stimulation means applied in the indoor environment.
		11 Feelings and Sensations	Information about positive stimulation linked to feelings and sensations.
		12 Quality of Support Spaces	Evaluation of the spaces supporting the core functions of the building.
Accessibility and Functionality	Usability	1 Access to building	Evaluation of the accessibility to the building and in the building.
		2 Orientation	Evaluation of building use without unnecessary assistance.
		3 Adjustability	Evaluation of easiness to use and control indoor conditions (temperature, humidity, light, etc.).
	Adaptability	4 Versatility and protection	Capability of the building to adapt to changing needs and use of the building.
		5 Tecnical service life	Evaluate technical service life of building load bearing structures, systems and components.
		6 Adaptability to climate change	Estimate how the building is protected against or may reduce the impacts of climate changes.
	Serviceability	7 Image, branding and cultural heritage	Evaluation of entrance, lobby and general appearance of spaces in terms of appearance and spaciousness for image and branding.
		8 Availability of services in the building	Review of services in the building or facility and its immediate surroundings that are available to users.
		9 Cleanliness	Review the durability of materials, the easiness of cleaning and the standard of cleaning in terms of work resources allocated .
		10 Maintainability	Maintainability is the ability of a building to be retained in a state in which it can perform its required functions or to be restored to such a state when a fault occurs.

The Indicators are divided into three main categories:

- **Health and Comfort.** This category includes the evaluation of the parameters related to the healthiness of the indoor environment and the comfort of people working or living in the building or simply visiting it.
- **Feeling of Safety and Positive Stimulation.** This category is mainly related to the building structures and equipments that could improve the security and safety perception of people and objects inside the building. Also information and data protection is taken into account. In this category, the indicators related to the positive effects that could improve the quality of life for people living or working in the building.
- **Accessibility and functionality.** The last category includes the indicators related to the easiness in using the building by people (workers, visitors, residents, managers, etc.), like the presence of services, the accessibility to the structure, the easiness of movement inside the building, and so on.

Each category is made by performance indicators, that are further characterized by specific technical indicators. This section will provide some concise information for these technical indicators, that are coming from the WP1. This information will be used as a basis for the implementation of the toolbox in the form of an Excel sheet. Then, the sheet will be implemented in the web-based decision support tool, object of T2.3.

The basic information provided for each specific indicator is:

- Name. A short name to properly identify the indicator among the whole list.
- Description. A short description of the meaning of the indicator. This information is very important and is used in the decision support tools to assist the user in entering the data.
- Unit. The unit with which the indicator is measured.
- Assessment Method. The assessment of the various indicators is not trivial. First of all, a distinction between the design phase and the building in use is necessary. During the design phase it is not possible to carry out specific measurements, thus proper simulations have to be carried out in order to choose the best solutions. On the contrary, in existent buildings it is possible to perform site visits and measurements to obtain data and perform a full building assessment. In both cases, the indicators will be assessed through five performance levels (from A to E, where A is the highest and E the lowest), summarized in D1.5.

The analysis is carried out accordingly to the three different categories of indicators. A more detailed description of the various indicators and the assessment methods could be found in D1.5.

2.1. Health and Comfort

This section contains the indicators identified to assess the level of health and comfort for the indoor environments. Five performance indicators have been identified in this category:

1. **Indoor Air Quality.** Indoor Air Quality is related to the quality of the indoor environment in terms of temperature and relative humidity and presence of air polluting substances in the indoor microclimate that could be a hazard for human health.
2. **Quality of Drinking Water and Reuse Water.** Water Quality refers to the availability of water and the presence in it of chemical or biological pollutants. The indicator evaluation includes the presence and the quality of system for water re-use.
3. **Thermal Comfort.** Thermal comfort is related to the thermal sensations perceived while performing the required tasks in an indoor environment.
4. **Visual Comfort.** Visual Comfort is related to the presence of daylight and/or adequate lighting solutions suitable for the performed tasks. The presence of light in a room also has a positive effect, psychologically and biologically, upon human well-being.

5. **Acoustic Comfort.** Acoustic Comfort is related to provide acoustic conditions in a building that facilitate clear communication of speech between the users of the building, and silence whenever needed.

Table 2 contains the performance and specific indicators defined for health and comfort.

Table 2: Summary of performance indicators for health and comfort

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
Indoor Air Quality	Effective Temperature	[-]	Temperature [°C] and relative humidity [%RH] are combined into one indicator called effective temperature.	<u>Simple</u> : Expert review of the expected effective temperature	<u>Simple</u> : Expert review of the effective temperature in the indoor environment
				<u>Detailed</u> : Simulation of the temperature and relative humidity values in the indoor environment	<u>Detailed</u> : On-site measurements of temperature and relative humidity
	Effective Ventilation / CO ₂	Ppm	The effective ventilation of a space is characterized by the carbon dioxide (CO ₂) concentration in a room.	<u>Simple</u> : Expert review of the designed ventilation systems.	<u>Simple</u> : Expert reviews of the ventilation systems, including the evaluation of air change rate. Also, survey among occupants could be carried out.
				<u>Detailed</u> : Evaluation of the designed ventilation systems through simulations	<u>Detailed</u> : On-site measurements of the CO ₂ concentration in the indoor environment
	Combustion Sources / Infiltration	Ppm	Carbon monoxide is an appropriate air quality measure because of the significance of the health effects and associated risk and liability of this contaminant.	<u>Simple</u> : Expert review of the possible sources of carbon monoxide (internal and external) and the designed countermeasures.	<u>Simple</u> : Expert review of the possible sources of carbon monoxide (internal and external) and the implemented countermeasures.
				<u>Detailed</u> : Evaluation of the estimated concentration of carbon monoxide through simulations	<u>Detailed</u> : On-site measurement of the carbon monoxide concentration in the indoor environment.
Odour Acceptance	[-]	The judgment of odours is a valuable tool for diagnosing potential indoor air quality problems.	<u>Simple</u> : Expert review of the designed preventive measures to avoid odours.	<u>Simple</u> : Expert reviews of the measures adopted to reduce odours. Also, survey among occupants could be carried out.	
			<u>Detailed</u> : Evaluation of applied materials and preventive measures.	<u>Detailed</u> : On-site measurement of chemical concentrations, if possible	
Particulate Matter Concentration	[µg/m ³]	Particulates (P < 2.5µg/m ³) are defined as suspended mixtures of solid or liquid particles.	<u>Simple</u> : Expert review of the designed preventive measures to reduce particulate matter concentrations.	<u>Simple</u> : Expert reviews of the measures adopted to reduce particulate matter concentrations. Also, survey among occupants could be carried out.	
			<u>Detailed</u> : Evaluation of designed solutions and preventive measures through simulations.	<u>Detailed</u> : On-site measurement of particulate matter, if possible	
Quality of drinking water use and reuse water	Drinking Water Quality	[-]	The quality of drinking water in a building is mainly determined by the definition and the implementation of a water safety plan.	<u>Simple</u> : Expert review about the definition of a water safety plan for drinking water system.	<u>Simple</u> : Expert review of the implementation of the water safety plan for drinking water system.
				<u>Detailed</u> : Evaluation of the defined water safety plan for drinking water system.	<u>Detailed</u> : Evaluation of the implementation of the water safety plan for drinking water system.

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
	Rain/reuse Water Quality		The quality of grey and rain water in a building is mainly determined by the definition and the implementation of a water safety plan.	<u>Simple</u> : Expert review about the definition of a water safety plan for gray and rain water.	<u>Simple</u> : Expert review of the implementation of the water safety plan for gray and rain water.
				<u>Detailed</u> : Evaluation of the defined water safety plan for gray and rain water.	<u>Detailed</u> : Evaluation of the implementation of the water safety plan for gray and rain water.
Thermal Comfort	Operative Temperature	[°C]	The operative temperature inside a building, depending on the different activities that are performed.	<u>Simple</u> : Expert reviews of the designed heating system in the building.	<u>Simple</u> : Expert reviews of the heating system and the operative temperature of the indoor environment. Also, survey among occupants could be carried out.
				<u>Detailed</u> : Evaluation of the operative temperature based on calculations or simulations of the building design.	<u>Detailed</u> : Measurement of the air temperature, mean radiant temperature, air velocity and partial water vapour pressure.
Visual Comfort	Illuminance	[lux]	A satisfactory visual performance is a sufficient illuminance for the specific visual tasks which are carried out in the room.	<u>Simple</u> : Expert reviews of the solutions adopted to provide a sufficient level of illuminance in the rooms.	<u>Simple</u> : Expert reviews of the solutions implemented to provide a sufficient level of illuminance in the rooms.
				<u>Detailed</u> : Calculation of the illuminance based on the documentation of the lighting installed and the properties of the space	<u>Detailed</u> : On-site measurements and calculation of the illuminance level in the rooms.
	Daylight Factor	[%]	The daylight factor is the ratio of the illuminance from the skylight inside the building with the illuminance from the skylight on the same surface with an unobstructed access to the sky.	<u>Simple</u> : Expert reviews of the solutions adopted to guarantee an adequate daylight illumination in the rooms.	<u>Simple</u> : Expert reviews of the solutions implemented to provide an adequate daylight factor in the rooms.
				<u>Detailed</u> : Calculation of the daylight factor based on the window surface and building exposition to the sun.	<u>Detailed</u> : On-site measurements and calculation of the daylight factor in the room
Acoustic Comfort	Background Noise Level	[dB]	The background noise level represents the average noise level over 30 minutes.	<u>Simple</u> : Expert review on estimation of the predicted background noise level on the basis of the evaluation of outdoor sources and the insulation properties of the materials.	<u>Simple</u> : Expert reviews of the background noise levels in the building.
				<u>Detailed</u> : Evaluation of the background noise level through simulations of the indoor environment	<u>Detailed</u> : On-site measurement of the background noise level
	Reverberation Time	[s]	The reverberation time reflects the presence of echoes with a relevant impact on communication between people	<u>Simple</u> : Expert review on estimation of the predicted reverberation time on the basis of the evaluation of outdoor sources and the insulation properties of the materials.	<u>Simple</u> : Expert reviews of the presence of disturbing echoes in the building, also with the aid of user surveys.

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
				<u>Detailed</u> : Evaluation of the reverberation time through simulations of the indoor environment	<u>Detailed</u> : On-site measurement of the reverberation time

2.2. Feeling of safety and Positive Stimulation

This section contains the indicators identified to evaluate the building structure from the point of view of safety (considering the building, the people working or living in it, the visitors and the valuable objects inside it), security (considering the possible threats against people, objects and information) and positive stimulation (to evaluate the effects of building on people). Three performance indicators have been identified in this category:

1. **Safety.** Safety is related to the evaluation of the possible risks that could pose a menace to people and the objects in the building. This indicator considers the presence of adequate escape routes and the compliancy to national and international regulations in terms of safe environments. Also the conditions for a proper conservation of artworks inside the building are analyzed.
2. **Security.** Security is related to the evaluation of the vulnerabilities of the building with respect to natural and human hazards and terrorism. Particular attention is dedicated to the protection of critical data that could be used, for example, to exploit the building vulnerabilities and provoke damages.
3. **Positive Stimulation.** Positive Stimulation is related to all those aspects that make people comfortable in using the building, from the reduction of stress in the working environment to the improvement of social support in healthcare.

Table 3 contains the performance and specific indicators defined for the “Feeling of safety and Positive Stimulation” category. All of these indicators are assessed through expert reviews and are evaluated through five performance levels.

Table 3: Summary of performance indicators for "Feeling of safety and Positive Stimulation" category.

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
Safety	Safety in Use	[-]	Safety issues linked to five categories of risks: glazing, slips, trips and falls, entrapment and falling objects.	<u>Simple</u> : Expert reviews of the design plans to check if there are possible risks for people and objects.	<u>Simple</u> : Expert review about the possible risks related to the categories of risks.
				<u>Detailed</u> : Calculation of the possible risks, on the basis of the design plans.	<u>Detailed</u> : On-site measurements of the possible risks related to the defined categories.
	Feeling of Safety	[-]	Human feeling of safety	<u>Simple</u> : Expert review about the expected feeling of safety by future users	<u>Simple</u> : User surveys about the feeling of safety by building occupants.
				<u>Detailed</u> :	<u>Detailed</u> :
	Meeting Current Regulation	[-]	Check if regulations linked to fire, structural, electrical, magnetic fields, non ionizing radiations and radioactivity have been respected	<u>Simple</u> : Expert reviews of the design plans to check if the national regulations are respected.	<u>Simple</u> : Expert reviews, aiming at analyzing if the national regulations are respected.
				<u>Detailed</u> : Detailed analysis of the design plans to check if the national regulations are respected.	<u>Detailed</u> : On-site visits aiming at verifying if the national regulations are respected.

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
	Cultural Heritage Protection	[-]	Suitability of the indoor environment to host artworks, analyzing physical and chemical parameters and use of equipments to prevent objects degradation.	<u>Simple</u> : Expert review of the designed environment to check if it is suitable for the proper conservation of artworks and if proper control systems have to be installed.	<u>Simple</u> : Expert review based on visual inspection to check if damages are present on artworks.
				<u>Detailed</u> : Simulation of the designed environment to check if it is suitable for the proper conservation of artworks and if proper control systems have to be installed.	<u>Detailed</u> : Measurements of environmental parameters to check if it is suitable for the proper conservation of artworks and environmental compatibility is possible between different artwork types.
Security	Personal and Material Security	[-]	This indicator checks if adequate protection measure are taken against criminality toward people and objects.	<u>Simple</u> : Expert reviews of the design plans to check if there are solutions to prevent crimes against users.	<u>Simple</u> : On site verification by expert review of the efficiency of the adopted solutions.
				<u>Detailed</u> : Detailed analysis of the design plans to check if there are solutions to prevent crimes against users..	<u>Detailed</u> : On-site visits to check the efficiency and the proper implementation of the security measures.
	Security of information	[-]	Evaluating of the security of information, by analyzing the compliancy with international standards related to the management of sensible data.	<u>Simple</u> : Expert reviews to evaluate the compliancy of the designed systems with the requirements of international standard (e.g. ISO 27000 family). <u>Detailed</u> :	<u>Simple</u> : Expert reviews to evaluate the compliancy of the adopted systems with the requirements of international standard (e.g. ISO 27000 family). <u>Detailed</u> :
	Protection against terrorism	[-]	Check if oportune countermeasures are taken to prevent damages from terrorist attacks	<u>Simple</u> : Expert evaluation of the building design to check if proper countermeasure have been designed. <u>Detailed</u> :	<u>Simple</u> : On site verification by experts to guarantee that proper countermeasure are adopted. <u>Detailed</u> :
Positive stimulation	View to outside	[-]	Evaluation of an average view to outside from the perspective of focal spaces in the building.	<u>Simple</u> : Expert reviews of the design plans to evaluate the possible view from the indoor environment. <u>Detailed</u> :	<u>Simple</u> : Expert reviews of the view to outside from the focal spaces in the building. <u>Detailed</u> :
	Architectural design	[-]	Evaluation of the aesthetic quality of the building based on the judgement of space solutions, spatial relations and forms and quality impression of fitting and surfaces	<u>Simple</u> : Expert reviews of the design plans. <u>Detailed</u> :	<u>Simple</u> : Expert reviews of the architectural properties of the building. <u>Detailed</u> :

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
	Visual stimulation	[-]	Information about visual positive stimulation means applied in the indoor environment.	<u>Simple</u> : Expert reviews of the design plans to check the presence of visual positive stimulation solutions.	<u>Simple</u> : On site expert reviews of the adopted solutions for visual positive stimulation.
				<u>Detailed</u> :	<u>Detailed</u> :
	Feelings and sensations	[-]	Information about positive stimulation linked to feelings and sensations.	<u>Simple</u> : Expert reviews of the design plans to check the presence of positive stimulation solutions linked to feelings and sensations	<u>Simple</u> : On site expert reviews of the adopted solutions for positive stimulation linked to feelings and sensations.
				<u>Detailed</u> :	<u>Detailed</u> :
	Quality of support spaces	[-]	Evaluation of the spaces supporting the core functions of the building.	<u>Simple</u> : Expert reviews of the design plans to check the presence and the quality of support spaces.	<u>Simple</u> : On site expert reviews of the presence and the quality of support spaces in the building.
				<u>Detailed</u> :	<u>Detailed</u> :

2.3. Accessibility and Functionality

This section contains the indicators that play an important role in the evaluation of the easiness of use of the indoor environment of a building for people working, living or simply visiting it. Three performance indicators have been identified in this category:

1. **Usability.** Usability, or functionality in use, is concerning the buildings ability to support the user organization’s economical and professional objectives. The quality of use for a building means that it is efficient in use (use of resources, productivity, effectiveness, rationality), offers the desired effect in use (increasing the value), and offers the desired quality in use (user satisfaction). Usability mainly focuses on accessibility and the easiness of movement inside the building.
2. **Adaptability.** The Adaptability of buildings could be defined as their “*ability to be changed or modified to make suitable for a particular purpose. Adaptability includes aspects of flexibility and convertibility*”. Good adaptability of a building should assure its functionality over time and during changes in user demands and needs, and new ways of using the building.
3. **Serviceability.** Serviceability could be defined as “*ability to meet or exceed relevant performance requirements*”. Another definition is: “*the fitness for purpose and thus the ability of a building to fulfil the user requirements from the functional point of view*”.

Table 4 contains the performance and specific indicators that fall in the “Functionality” category. Except Technical service life indicator, all of these indicators are assessed through expert reviews and are evaluated through five performance levels.

Table 4: Summary of other performance indicators

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
Usability	Access to Building	[-]	Evaluation of the accessibility to the building and in the building.	<u>Simple</u> : Expert reviews of the design plans to check the presence of solutions to improve accessibility and to verify if universal design principles have been respected.	<u>Simple</u> : On site expert reviews and/or user satisfaction surveys.

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
				<u>Detailed:</u> Detailed analysis of the design plans with regard to universal design principles or respect of accessibility standards or regulations.	<u>Detailed:</u> On-site visits, measurements and user satisfaction surveys focussing if necessary on the needs of specific user groups.
	Orientation	[-]	Evaluation of building use without unnecessary assistance.	<u>Simple:</u> Expert reviews of the design plans to evaluate the easiness of navigation inside the building.	<u>Simple:</u> On site expert reviews of the adopted solutions for improve the orientation inside the building.
				<u>Detailed:</u>	<u>Detailed:</u>
	Adjustability	[-]	Evaluation of easiness to use and control indoor conditions (temperature, humidity, light, etc.)	<u>Simple:</u> Expert reviews of the design plans to evaluate the solutions adopted to control the building indoor conditions.	<u>Simple:</u> On site expert reviews of the adopted solutions to control the building indoor conditions.
				<u>Detailed:</u>	<u>Detailed:</u>
	Adaptability	Versatility and protection	[-]	Capability of the building to adapt to changing needs and use of the building.	<u>Simple:</u> Expert reviews of the design plans to evaluate the capability of the building to adapt to changing needs.
<u>Detailed:</u>					<u>Detailed:</u>
Technical Service Life		[years]	Evaluate technical service life of building load bearing structures, systems and components.	<u>Simple:</u> Expert reviews of structures, equipments and systems to be installed in the building under design.	<u>Simple:</u> Expert reviews of structures, equipments and systems that are installed in the building.
				<u>Detailed:</u>	<u>Detailed:</u>
Adaptability to Climate Change		[-]	Estimate how the building is protected against or may reduce the impacts of climate changes.	<u>Simple:</u> Expert reviews of the design plans to evaluate the solutions adopted to guarantee protection against future climate changes	<u>Simple:</u> Expert reviews of the presence and implementations of solutions to guarantee protection against future climate changes for the building.
				<u>Detailed:</u>	<u>Detailed:</u>
Serviceability	Image and Branding and Cultural heritage	[-]	Evaluation of entrance, lobby and general appearance of spaces in terms of appearance and spaciousness for image and branding	<u>Simple:</u> Expert reviews of the design plans to assess the importance of the building from an architectural and/or cultural point of view.	<u>Simple:</u> Expert reviews of the building to assess the its importance from an architectural and/or cultural point of view.
				<u>Detailed:</u>	<u>Detailed:</u>
	Availability of services in the building	[-]	Review of services in the building or facility and its immediate surroundings that are available to users	<u>Simple:</u> Evaluation of the design plans to check the presence of available services, selected from a list specifically related to that building type.	<u>Simple:</u> Evaluation of the building and its surrounding to check the presence of available services, selected from a list specifically related to that building type.
				<u>Detailed:</u>	<u>Detailed:</u>

Performance Indicator	Specific Indicator	Unit	Description	Assessment	
				Design	Operation
	Cleanliness	[-]	Review the durability of materials, the easiness of cleaning and the standard of cleaning in terms of human resources allocated .	<u>Simple</u> : Expert reviews of design plans based on the analysis of materials and easiness to clean spaces. <u>Detailed</u> :	<u>Simple</u> : Expert reviews of the quality of the cleaning operations and of the human resources allocated for this activity. <u>Detailed</u> :
	Maintainability	[-]	Maintainability is the ability of a building to be retained in a state in which it can perform its required functions or to be restored to such a state when a fault occurs.	<u>Simple</u> : Expert reviews about the definition of a proper maintenance plan.	<u>Simple</u> : Expert reviews of the presence, the implementation and the efficiency of a proper maintenance plan.

2.4. Application in Building Types

In the PERFECTION project, the analysis is focused on some building types, which represent the vast majority of building uses currently in operation or being in design phase. The identified building types are:

- Office: buildings mainly dedicated to the office work, including open space or individual offices.
- School: buildings dedicated to educational activities, like school, universities, etc.
- Housing: residential buildings
- Hospital: structures dedicated to healthcare, like hospitals, nursery, etc.
- Exhibitions Place: buildings such as museums that mainly host objects with a great relevance from the cultural, artistic and historical point of view, even only for temporary exhibitions.

Each of these types could be hosted in a historical building, which poses strong constraints on the works that can be done to improve the indoor environment. In such cases, the assessment process has to take into account these constraints when the evaluation is performed.

2.5. Sustainability Impact

Before performing a complete evaluation of the building, it is necessary to define a matrix that identifies the impact of the performance indicators on the sustainability properties (social, environmental and economic). This linkage between indicators and sustainability properties is based on a three level scale (three stars is the maximum, while one star is the minimum).

Σφάλμα: Δεν βρέθηκε η πηγή παραπομπής provides an indication of the impact of each indicator on the sustainability properties identified in the T2.2 indicator toolbox. These impacts are categorized in stars and are a draft that through a deeper analysis in collaboration with relevant stakeholders may be updated later in the PERFECTION project. More detailed way how calculations are made is showed in the chapter 3.3.2 Indoor Sustainability impacts.

		Sustainability				
		Name	Social	Environmental	Economic	
HEALTH AND COMFORT	Indoor Air Quality	1	Effective temperature	***	**	**
		2	Effective ventilation / CO2	***	*	**
		3	Combustion sources / infiltration	***	*	*
		4	Odour acceptance	***	*	*
		5	Particulate matter	***	*	*
	Water Quality	6	Drinking water quality	***	*	*
		7	Rain/re-use water quality	***	***	*
	Thermal Comfort	8	Operative temperature	***	**	**
	Visual Comfort	9	Illuminance	***	**	*
		10	Daylight factor	***	**	**
	Acoustic Comfort	11	Background noise level	***	*	**
		12	Reverberation time	***	*	**
FEELING OF SAFETY AND POSITIVE STIMULATION	Safety	1	Safety in use	***	*	***
		2	Feeling of safety	***	*	*
		3	Meeting current regulation	*	***	***
		4	Cultural heritage protection	***	*	**
	Security	5	Personal and material security	***	**	***
		6	Security of Information	**	*	***
		7	Protection against terrorism	***	*	***
	Positive Stimulation	8	View to outside	***	*	*
		9	Architectural design	***	*	*
		10	Visual stimulation	***	*	*
		11	Feelings and sensations	***	*	*
		12	Quality of support places	***	*	*
FUNCTIONALITY	Usability	1	Access to building	***	*	*
		2	Orientation	***	*	*
		3	Adjustability	**	***	*
	Adaptability	4	Versatility and protection	*	**	***
		5	Tecnical service life	*	**	***
		6	Adaptability to climate change	**	***	**
	Serviceability	7	Image, branding and cultural heritage	***	**	***
		8	Availability of services in the building	***	**	***
		9	Cleanliness	***	*	**
		10	Maintanibility	*	**	***

Figure 1: Impact of the indicator on the sustainability properties.

2.6. Building Reference

One of the main goals of the KIPI (Key Indoor Performance Indicators) framework is to provide a benchmark of buildings against a standard performance level. The benchmark is performed either for buildings in the design phase or the operation phase. When developing the indicator framework, it was noticed that it's not easy to define a unique standard level for different building types analyzed. Therefore, we have described the indicator framework where same indicators are used for all building but how indicators are valued in different building types, meaning offices, schools, housing, hospitals, and exhibition places, changes. For example personal and material safety is more important in hospitals than in housing and how these differences are expressed is explained in chapter 2.7 Indicator weight.

When assessing indicators in the building project, it's better to define a standard performance level for each building type. A reference building is defined as a building whose performance level for any indicator relevant for its building type is satisfactory and compliant with standards or regulations. If there are different national regulations that could be applied, the strictest one has to be taken into account, as if a building is compliant with the strictest conditions, then it will be compliant with all the applicable regulations.

Even if some differences between the various European areas could be present, it's really important to define a unique reference for each building type in order to make them comparable between each other.

2.7. Indicator Weight

An important role in the computation process is played by "weights". Strictly speaking, these are coefficients by which the obtained scores are multiplied in order to obtain the final score of the building or product under evaluation. Weights have a great importance as they could drive the attention to particular indicators, instead of others, maybe reflecting country peculiarities or regulations.

There are different ways on how weights are assigned to indicators.

1. Weights are fixed by the tool developers and the final user has no power to change them. From a technical point of view, this approach is the simplest to implement. However, it greatly limits the user capability to adapt the tools to his needs.
2. Buildings are divided into categories depending on their final use. For each of these categories a different set of weights is assigned to the indicators. Using this approach simply requires that the final user has to choose which category his building belongs to, thus the proper weights are selected and the final building score can be computed.
3. The user can freely assign weights to each indicator. In this way, user has the maximum level of adaptation of the tool. Each weight could range from 0 to 1 independently from the others, or it could be decided that the sum of weights must be a fixed value. This second solution forces the user to establish priorities between the indicators. However, with this approach it can be quite impossible to compare the score of two different buildings evaluated by different users.
4. A combination of the first and the third methods, where a fixed set of weights is provided, but users can adapt the weight distribution according to their needs and requirements. However, if the user chooses to work with own weights, this approach has the same main drawback as the third one: Two different buildings evaluated by different users will not be comparable.
5. A combination of the second and the third methods. In addition to the building types defined by the tool developers, users can define, and share with the others, their own building types and provide a proper set of weights for the newly defined building types. With this approach, buildings can be compared accordingly to their type. Also in this case, the freedom should be given to the user to go for an own weighting scheme: in each case it will remain an open discussion who gives the authority and power to choose weights to be used by others.

A first draft for the weights in a general building is taken up in Figure . However, preliminary discussions with stakeholders revealed that these general building weights have shortcomings, and therefore, those will be updated later to separate weights for the different building types in the Perfection project. In relation to earlier, it was noticed that in some cases considerations are also case specific or related to a certain market area.

Each indicator is provided with a score or grade, which is computed according to the assessment ranging from best class A to lowest class E. The assessment of each indicator is multiplied by proper “weight”, that means a number ranging from 0 to 1 (0% to 100%) and the sum of all indicators equals to 1. When developing separate weights for the different building types, building type impact matrix defined in chapter 2.8 Building Type Impact Matrix can be used as a baseline.

		Name			weights	
HEALTH AND COMFORT 33 %	Indoor Air Quality	1	Effective temperature	39 %	100 %	6,6 %
		2	Effective ventilation / CO2	39 %		6,6 %
		3	Combustion sources / infiltration	8 %		1,3 %
		4	Odour acceptance	8 %		1,3 %
		5	Particulate matter	8 %		1,3 %
	Water Quality	6	Drinking water quality	60 %	100 %	2,0 %
		7	Rain/re-use water quality	40 %		1,3 %
	Thermal Comfort	8	Operative temperature	100 %	100 %	0,3 %
	Visual Comfort	9	Illuminance	60 %	100 %	4,2 %
		10	Daylight factor	40 %		2,8 %
	Acoustic Comfort	11	Background noise level	70 %	100 %	3,7 %
		12	Reverberation time	30 %		1,6 %
33 %						
FEELING OF SAFETY AND POSITIVE STIMULATION 40 %	Safety	1	Safety in use	25 %	100 %	3,0 %
		2	Feeling of safety	25 %		3,0 %
		3	Meeting current regulation	25 %		3,0 %
		4	Cultural heritage protection	25 %		3,0 %
	Security	5	Personal and material security	68 %	100 %	7,1 %
		6	Security of Information	17 %		1,8 %
		7	Protection against terrorism	15 %		1,6 %
	Positive Stimulation	8	View to outside	37 %	100 %	6,6 %
		9	Architectural design	7 %		1,2 %
		10	Visual stimulation	7 %		1,2 %
		11	Feelings and sensations	37 %		6,6 %
		12	Quality of support places	11 %		1,9 %
40 %						
FUNCTIONALITY 27 %	Usability	1	Access to building	30 %	100 %	2,7 %
		2	Orientation	46 %		4,1 %
		3	Adjustability	24 %		2,2 %
	Adaptability	4	Versatility and protection	63 %	100 %	5,7 %
		5	Tecnical service life	22 %		2,0 %
		6	Adaptability to climate change	16 %		1,4 %
	Serviceability	7	Image, branding and cultural heritage	28 %	100 %	2,5 %
		8	Availability of services in the building	17 %		1,5 %
		9	Cleanliness	22 %		2,0 %
		10	Maintanability	33 %		2,9 %
27 %						

Figure 2: Weight evaluation for the indicator framework

Through a combination between the weights indicated in Figure and the impact levels for sustainability defined in Σφάλμα: Δεν βρέθηκε η πηγή παραπομπής, it is possible to compute also the indoor sustainability rating for the building. The combination of weights and building impacts could also define a prioritization during the assessment phase, identifying which are the most relevant indicators for the building type under analysis.

2.8. Building Type Impact Matrix

In the PERFECTION project, the analysis is focused on valuing indicators differently between different building types - offices, schools, housing, hospitals, and exhibition places. Σφάλμα: Δεν βρέθηκε η πηγή παραπομπής shows the linkage between the indicators and building types according to their relevance. The linking is based on a three level scale (three stars is the maximum, while one star is the minimum; a white star means that the indicator is not relevant for that building type) and it can be used later as a starting point for the development of weights for the different building types.

Even if there are some holes in the matrix, it's possible to evaluate all indicators for a building type, keeping in mind that some indicators were defined with a reference to a specific context and their application in other context might be difficult and proposed assessment method has to be changed.

		Name	Building Type				
			Offices	School	Housing	Hospital	Exhibition
HEALTH AND COMFORT	Indoor Air Quality	1 Effective temperature	***	***	***	***	***
		2 Effective ventilation / CO2	**	**	***	***	*
		3 Combustion sources / infiltration	***	**	***	***	**
		4 Odour acceptance	***	**	***	***	*
		5 Particulate matter	***	**	***	***	**
	Water Quality	6 Drinking water quality	*	**	***	***	*
		7 Rain/re-use water quality	*	**	***	***	*
	Thermal Comfort	8 Operative temperature	***	***	***	***	***
	Visual Comfort	9 Illuminance	***	***	☆	***	**
		10 Daylight factor	***	***	***	***	☆
	Acoustic Comfort	11 Background noise level	***	***	***	***	***
		12 Reverberation time	***	***	☆	**	☆
FEELING OF SAFETY AND POSITIVE STIMULATION	Safety	1 Safety in use	***	***	***	***	***
		2 Feeling of safety	***	***	***	***	**
		3 Meeting current regulation	***	***	***	***	***
		4 Cultural heritage protection	☆	☆	☆	☆	***
	Security	5 Personal and material security	***	**	***	***	***
		6 Security of information	***	**	☆	***	☆
		7 Protection against terrorism	***	***	**	***	**
	Positive Stimulation	8 View to outside	**	**	***	***	**
		9 Architectural design	***	***	***	***	***
		10 Visual stimulation	**	**	*	***	***
		11 Feelings and sensations	*	*	*	**	***
		12 Quality of support places	***	**	*	***	**
ACCESSIBILITY AND FUNCTIONALITY	Usability	1 Access to building	***	***	***	***	***
		2 Orientation	**	***	*	***	***
		3 Adjustability	**	**	***	***	***
	Adaptability	4 Versatility and protection	***	**	**	***	***
		5 Technical service life	**	**	***	***	**
		6 Adaptability to climate change	**	**	***	***	*
	Serviceability	7 Image, branding and cultural heritage	***	**	**	**	***
		8 Availability of services in the building	***	**	*	***	***
		9 Cleanliness	***	***	☆	***	**
		10 Maintainability	***	**	*	***	**

Figure 3: Applicability of indicators to building types.

3. TOOLBOX DESCRIPTION

This section will provide a brief description of the Excel toolbox implemented in order to evaluate a building with the KIPI framework.

The toolbox is divided into two main sections: the first one is related to the general information regarding the building, while the second one is dedicated to the assessment of the performance indicators and the computation of the building score.

3.1. General Information

The first section of the indicator toolbox is dedicated to the collection of general information regarding the building under analysis. This information is used to provide a synthetic description of the building, with an indication of the dimension, the activities performed and the number of users. In this section, some preliminary information about the equipments for heating and ventilation systems and an estimation of the annual energy consumptions are provided.

Table 5: General information form

GENERAL INFORMATION	
<i>Location</i>	
Name	Name of the building
Country	Country where the facility is located
Address, postal code and city	Postal address to the building site
Region	Region characteristics from the list
Location coordinates	Google Earth/maps latitude and longitude values
<i>Project Participants</i>	
Owner	Owner name
Architect	Architect name
Main Contractor	Main Contractor name
Number of Managers	Number of people managing the building
Users	Users listed, quantities by personnel and/or floor area
<i>Site</i>	
Size of the plot	Total area of the site
Building efficiency and density	Proportion of land used for building, (building net floor area / size of the plot)
Spatial quality of outdoor spaces	Way building is placed and formed in relation to the surrounding buildings, area or landscape and the spatial quality
Available services in neighbourhood	List of available services in the building proximity
<i>Building</i>	
Type of project	Select type of project
Type of building	Main function of the building
Cultural Value	Does the building have a relevant cultural or historical value
Shape of building	Architectural quality of the building, consideration of the shape and form
Number of storeys	Give number of storeys, average value may used
Build-up area	Area of building's footprint
Gross floor area	Total floor area of the building on all floors including exterior and interior walls
Net floor area	Total floor area of the building on all floors excluding exterior and interior walls
Building space	Total volume (area and height) of the building
Number of main space groups	Define number of main space groups and quantities of individual types in the building
Main space group quantities	Define names and quantities of main space groups
Water consumption	Annual total consumption of water per person
Heating energy consumption	Annual consumption of heating energy per gross area square meter
Electricity consumption	Annual consumption of electricity per gross area square meter
Carbon footprint	Carbon footprint calculation has been implemented
Number of occupiers	Amount of persons that use the building
Vacancy rate	Proportion of the vacancy in the building
Year of construction	Year when building has been constructed
Renovation year	Year when building has been renovated or parts added to existing building
Project finished	Status whether project is finished or ongoing
Ventilation system	Write short description
Heating system	Write short description

HVAC Monitoring system	Write short description
User satisfaction survey	Has user satisfaction survey been made?

Table 5 shows the information required to fill in the general information section. A more detailed description of the various sections can be found in the following sections.

3.1.1. Location

The *location* part is important in placing the building in a specific context. The form requires the following information:

- *Name*: the name of the building.
- *Country*: the country where the building is located.
- *Address, postal code and city*: the full address of the building, including the road name and number, the postal code, the city and the province, if applicable.
- *Region*: a brief indication of the surrounding of the building. This indication could be chosen through a selection list (e.g. landscape, village, town, city, city centre).
- *Location coordinates*: the latitude and the longitude of the building. These data could be retrieved through services like Google Earth/Maps.

3.1.2. Project Participants

The *project participants'* part allows the identification of the owners and other people that are actively involved in the design or in the management of the building. The form requires the following information:

- *Owner*: the owner of the building (it could be a person, an organization, a Public Body, etc.). If possible, a contact link (website, e-mail) of the owner should be provided.
- *Architect*: the architect responsible for design or renovation. As in the case of the owner, a contact link should be provided.
- *Main Contractor*: main contractor (person or organization) responsible for management.
- *Number of Managers*: the number of people that have responsibilities in the building management.
- *Users*: the list of names of managers

3.1.3. Site

The *site* section provides some basic information about the relation between the building and the surrounding environment, taking into account the impact in terms of occupied area and the availability of services in the proximity. The form requires the following information:

- *Size of the plot*: the total area of the site expressed in [m²].
- *Building efficiency and density*: proportion of land used for building, calculation from building net floor area (see Section 3.1.4) in relation to the size of the plot.
- *Spatial quality of outdoor spaces*: the way the building is placed and formed in relation to the surrounding buildings, area or landscape and the spatial quality. Four performance level has been identified (excellent, good, satisfactory, unsatisfactory) and the user should select one of them.
- *Available services in neighbourhood*. A list of the available services in the building proximity.

3.1.4. Building

The *building* section contains information strictly related to the building itself, like the occupied area and volume, the activities performed inside it and some data related to the systems installed and the consumption of resources (water, energy, electricity, etc.). The form requires the following information:

- *Type of project*: identification if the building under analysis already exists or still under design. A third possibility is given by the extension of an existing building with new areas.

- *Type of building*: main function of the building, following the classification provided in Section 2.4 (office, school, housing, hospital, exhibition).
- *Spaces*: often a building could host spaces for different activities, each one with its peculiar requirements for indoor environment. In this section of the form, the user will have to insert the list of the building activities for which the assessment will be made.
- *Cultural Value*: indication if the building has a relevant cultural or historical value. This indication could have a relevant impact in the evaluation of some performance indicators.
- *Shape of building*: architectural quality (unique, conventional or simple) of the building, with consideration of the shape and form.
- *Number of storey*: number of storey of the building. If different building areas have different number of storey, the average value has to be used.
- *Build-up area*: area of building's footprint, expressed in [m²].
- *Gross floor area*: total floor area of the building on all floors including exterior and interior walls, expressed in [m²].
- *Net floor area*: total floor area of the building on all floors excluding exterior and interior walls, expressed in [m²].
- *Building volume*: total volume of the building, expressed in [m³].
- *Water consumption*: annual total consumption of water per person.
- *Heating energy consumption*: annual consumption of heating energy per gross area square meter.
- *Electricity consumption*: annual consumption of electricity per gross area square meter.
- *Carbon footprint*: indication if a carbon footprint calculation has been implemented or not.
- *Number of occupiers*: amount of persons that use the building (including an estimation of visitors).
- *Vacancy rate*: proportion of the vacancy in the building.
- *Construction year*: year when building has been constructed.
- *Renovation year*: year when building has been renovated or parts added to existing building.
- *Project finished*: status whether project is finished or ongoing (relevant for new building under construction or renovation)
- *Ventilation system*: short description of the ventilation system installed in the building, with a particular focus on solutions adopted in special rooms.
- *Heating system*: short description of the heating system installed in the building, with a particular focus on solutions adopted in special rooms.
- *HVAC Monitoring system*: short description of the HVAC monitoring system, if present, installed in the building
- *User satisfaction survey*: indication if there are procedures to check user satisfaction (surveys, interviews, etc.)

3.2. Indicator Evaluation

The second section of the indicator toolbox is related to the evaluation of the performance indicators.

The evaluation phase must be divided accordingly to the building status: *design assessment*, for new buildings or when renovation works have been planned but not yet executed to evaluate if the required performance levels will be met, and *in operation assessment*, for existing building to evaluate the current status and identify possible actions to improve the performances.

The main difference between the two assessments is the methodology to evaluate the indicators. In an existing building it is possible to perform on-site measurements or user surveys and interviews to rate the indicators. On the contrary, in new buildings the only way to rate the indicators is based on simulations or expert reviews of the design plans.

For each indicator in the KIPi framework a scale of five performance levels has been defined. Table 2, Table 3 and Table 4 provide the assessment methods for each indicator in the KIPi framework both in design and in operation phase. A more detailed description of the assessment methods for each indicator and of the performance levels identified could be found in D1.5. The evaluation is carried out in a simple way, through site visits, user surveys and interviews, etc. However, depending on the data available when performing the evaluation or on the results coming from the simple assessment, a more detailed evaluation could be required. In this way, the toolbox has a field to define which assessment methods was used for the indicator. Furthermore, there is a section where the user has to select which performance level has been reached during the various stages of the assessment. An additional section will allow the user to add comments related to the performed analysis and issues encountered during the assessment.

Typically, buildings are often used for different activities, with dedicated spaces and different requirements in terms of indoor performances. Thus, to have a complete evaluation of the building it is necessary that the assessment is performed for each activity space.

For example, a hospital could have rooms for patients, surgery rooms, laboratories to perform analysis, and a part with offices for the hospital administration. All these different spaces must be evaluated separately in order to better detect which areas have the poorest performances and consequently plan improvement works.

3.3. Indicator Assessment Tool

The purpose of the indicator assessment tool is to illustrate the overall indoor performance of a building evaluated in structured way. The calculations made possible by the Excel tool associated to this task are explained in this section.

The user of the tool needs first to fill in the Phase 1 general information sheet (see figure 4). Indicator evaluations are done in the Phase 2 assessment sheet (see figure 5). The following information about the building in question is automatically moved from the general information sheet: name, country, owner, type of project, type of building, gross floor area and construction year.

For the assessment of indicators the approach agreed and explained in T1.5 is implemented. Each indicator is assessed by defining a level from A to E. This is done by using the letter “x”. For the assessed indicators, the toolbox calculates values which in a sense describe the building’s indoor performance quality. An indicator assessment tool has been developed in order to evaluate the performance of the case studies dealt with in T2.4 and to help the further development of a web tool in T2.3.

The Excel tool computes values that describe the quality of the indoor performance as an overall KIPI score, an indoor sustainability rating and the coverage of selected KIPIs.

- The KIPI score is a value between 0 and 100 representing the indoor performance of a building in respect of the KIPI framework.
 - The Indoor Sustainability rating is a star between one and three and it illustrates the indoor sustainability impacts.
 - The KIPI coverage is a percentage. It represents the number of indicators assessed from the total number of available indicators in the KIPI framework.

3.3.1. Weights

Indicator weights are used in the tool for describing the importance of an indicator. At the moment, only weights determined in D1.5 for a general case are available. However, the relevance of indicators is highly dependent on the building. Therefore, the weights for each building type will be determined later in the Perfection project lifetime. The Excel tool contains ten columns for these alternative weights. As described in Section 2.7, the toolbox should in the end also leave possibilities to the users, to add building categories or types, to provide weights or to modify them according to own needs and priorities.

3.3.2. Indoor sustainability impacts

Sustainability impacts are illustrated with 1-3 stars as explained before in this report. As the existing impacts are determined by a subjective evaluation, they may be updated later. The tool contains three columns for alternative sustainability values.

It is worth of reminding that the scope of PERFECTION is on the indoor environment. As such, it is not the aim to make claims about the overall sustainability impacts of a building. The purpose is solely to describe how the indoor environment of the building contributes to the sustainability impact of the building.

perfection Key Indoor Performance Indicators Phase 1 - general information				
Description		Unit / Hint		Value
GENERAL INFORMATION				PAGE 1/2
Location				
1	Name	Name of the building	<i>[Name used also in KIPI assessment sheet]</i>	Example building
2	Country	Country where facility is located	<i>[Country name]</i>	Finland
3	Address, postal code and city	Postal address to building site	<i>[e.g. road name and number, postal code, city]</i>	
4	Region	Region characteristics from the list	<i>[land scape / village / town / city / city centre]</i>	
5	Location coordinates	Google Earth/maps latitude and longitude values	<i>[e.g. 60°10'57.50"P 24°49'41.23"E]</i>	
Project Participants				
6	Owner	Owner name	<i>[Name and website]</i>	VTT, www.vtt.fi
7	Architect	Architect name	<i>[Name and website]</i>	
8	Main contractor	Main contractor name	<i>[Name and website]</i>	
9	Number of managers	Number of people managing the building	<i>[Number of persons]</i>	
10	Users	Users listed, quantities by personnel and/or floor area	<i>[List of quantities]</i>	
Site				
11	Size of the plot	Total area of the site	<i>[m2]</i>	
12	Building efficiency and density	Proportion of land used for building, calculation from building net floor area / size of the plot	<i>[e.g. 1,5]</i>	
13	Spatial quality of outdoor spaces	Way building is placed and formed in relation to the surrounding buildings, area or landscape and the spatial quality	<i>[excellent / good / satisfactory / unsatisfactory]</i>	
14	Available services in neighborhood	List of available services in the building proximity, select from list	<i>[daycare, post office, bank, health care, dentist, pharmacy, restaurant, cafeteria, fast food, grocery store, special stores, bakery, kiosk, laundry, maintenance services, shoemaker, barber, library, congregation, exercise, recreation, cinema, market, park, walking street]</i>	
Building				
15	Type of project	Select type of project	<i>[existing / extension / new]</i>	existing
16	Type of building	Main function of the building	<i>[office / school / housing / hospital / exhibition]</i>	office
17	Cultural Value	Does the building have a relevant cultural or historical value	<i>[yes / no]</i>	
18	Shape of building	Architectural quality of the building, consideration of the shape and form	<i>[unique / conventional / simple]</i>	
19	Number of storeys	Give number of storeys, average value used when required	<i>[number]</i>	
GENERAL INFORMATION				PAGE 1/2
Description		Unit / Hint		Value

Description		Unit / Hint	Value
GENERAL INFORMATION			PAGE 2/2
Building			
20	Build-up area	Area of building's footprint [m2]	
21	Gross floor area	Total floor area of the building on all floors including exterior and interior walls [m2]	5000
22	Net floor area	Total floor area of the building on all floors excluding exterior and interior walls [m2]	
23	Building volume	Total volume (area and height) of the building [m3]	
24	Number of main space groups	Define number main space groups and quantities of individual types in the building [number]	
25	Main space group quantities	Define names and quantities of main space groups [type name and gross floor m2]	
26	Water consumption	Annual total consumption of water per person [l/person/a]	
27	Heating energy consumption	Annual consumption of heating energy per gross area square meter [kWh/m2/a (gross area)]	
28	Electricity consumption	Annual consumption of electricity per gross area square meter [kWh/m2/a (gross area)]	
29	Carbon footprint	Carbon footprint calculation has been implemented [yes / no]	
30	Number of occupiers	Amount of persons that use the building [Number of persons]	
31	Vacancy rate	Proportion of the vacancy in the building [% of area]	
32	Construction year	Year when building has been constructed [year]	1976
33	Renovation year	Year when building has been renovated or parts added to existing building [year]	
34	Project finished	status whether project is finished or ongoing [yes / no]	
35	Ventilation system	Write short description [e.g. Mechanical balanced ventilation + heat recovery, chilled beams in office spaces]	
36	Heating system	Write short description [e.g. Water convectors, air supply units]	
37	HVAC Monitoring system	Write short description [e.g. Automated continuous monitoring, direct reporting on energy, costs and operations to owner and manager]	
38	User satisfaction survey	Has user satisfaction survey been made [yes / no]	
GENERAL INFORMATION			PAGE 2/2
Description		Unit / Hint	Value

Figure 4: Indicator tool – phase 1: General information sheet.


perfection **Key Indoor Performance Indicators**
Phase 2 - assessment sheet

Name	Example building		
Country	Finland	Type of building	office
Owner	VTT, www.vtt.fi	Gross floor area	5000
Type of project	existing	Construction year	1976

	Name	Assessment in design					Comments	Assessment in operation					Comments					
		-	E	D	C	B		A	-	E	D	C		B	A			
HEALTH AND COMFORT	Indoor Air Quality	1	Effective temperature	X														
		2	Effective ventilation / CO2		X													
		3	Combustion sources / infiltration	X														
		4	Odour acceptance	X														
		5	Particulate matter	X														
Water Quality	6	Drinking water quality	X															
	7	Rain/re-use water quality			X													
Thermal Comfort	8	Operative temperature		X														
	9	Illuminance		X														
Visual Comfort	10	Daylight factor	X															
	11	Background noise level		X														
Acoustic Comfort	12	Reverberation time	X															

FEELING OF SAFETY AND POSITIVE STIMULATION	Safety	1	Safety in use	X														
		2	Feeling of safety	X														
		3	Meeting current regulation						X									
		4	Cultural heritage protection	X														
	Security	5	Personal and material security					X										
		6	Security of information	X														
		7	Protection against terrorism	X														
	Positive Stimulation	8	View to outside	X														
		9	Architectural design		X													
		10	Visual stimulation	X														
		11	Feelings and sensations		X													
		12	Quality of support places	X														

ACCESSIBILITY AND FUNCTIONALITY	Usability	1	Access to building	X														
		2	Orientation	X														
		3	Adjustability					X										
	Adaptability	4	Versatility and protection	X														
		5	Technical service life	X														
		6	Adaptability to climate change	X														
	Serviceability	7	Image, branding and cultural heritage	X														
		8	Availability of services in the building	X														
		9	Cleanliness	X														
		10	Maintainability					X										



Key Indoor Performance Indicators

KIPI score 40

HEALTH AND COMFORT 2

FEELING OF SAFETY AND POSITIVE STIMULATION 56

ACCESSIBILITY AND FUNCTIONALITY 100

Sustainability rating ★★★

SOCIAL ★

ENVIRONMENTAL ★★★★

ECONOMICAL ★★

KIPI coverage

	DESIGN	OPERATION
HEALTH AND COMFORT	32 %	0 %
FEELING OF SAFETY AND POSITIVE STIMULATION	42 %	0 %
ACCESSIBILITY AND FUNCTIONALITY	33 %	0 %
	20 %	0 %

Figure 5: Indicator tool – phase 2: KIPI indicator assessment.

3.3.3. KIPi score

The KIPi score explains how good or bad the indoor performance of the building is. It is calculated in relation to the performance on each or on a selection of the indicators and it takes into account the weights attributed to them. Only the assessed indicators are taken into account in the calculations and that does not influence the score. In other words, the assessment is not penalised for not selecting some indicators.

The reliability of the assessment score (and the scope of the assessment) is quantitatively illustrated by the KIPi coverage, which is simply the percentage of selected indicators

The assessment can be done for the design phase, the operation phase or both, in which case the score of each indicator is calculated as the average of the performance during design and operation. Also here, the absence of design or operation evaluations does not affect the score. In most cases, however, the idea is to evaluate only either the design or the operation phase.

The KIPi score is calculated in the following way as a relative percentage. Please consult the Excel tool at the same time to understand the terminology. The score is a value between 0 and 100.

$$KIPi\ score = 100 \times \frac{(Design_{now} + Operation_{now}) - (Design_{min} + Operation_{min})}{(Design_{max} + Operation_{max}) - (Design_{min} + Operation_{min})}$$

where $Design_{now} = weight \times Assessment\ coefficient$,
 $Design_{min} = weight \times Assessment\ coefficient\ E$ and
 $Design_{max} = weight \times Assessment\ coefficient\ A$
 and the same way for operation assessments.

3.3.4. Indoor sustainability rating

The indoor sustainability rating is an estimation of the building's indoor performance concerning social, environmental, and economic characteristics. They are expressed in stars from one to three. First, a score between 0 and 100 is calculated and then the stars are defined as follows: ★ (0-32), ★★ (33-66) and ★★★ (67-100). The limit values can be changed later. The overall rating is calculated in the following way.

Sustainability rating

$$= Average\left(\frac{(Social_{now} + Environmental_{now} + Economic_{now}) - (Social_{min} + Environmental_{min} + Economic_{min})}{(Social_{max} + Environmental_{max} + Economic_{max}) - (Social_{min} + Environmental_{min} + Economic_{min})}\right)$$

where $Social_{now}$ is the KIPi score multiplied by the number of stars and the same way for the others.

4. PRODUCT EVALUATION

4.1. Introduction

The KIPI indicator set besides serving to scientifically address and assess the **indoor performance of buildings** will be also used as a framework for publication of information about products that are, in some way, affecting positively a subset of the KIPI indicators, and are, in this way, contributing to a better IEQ. The rationale behind this development is the added value that can result by using the KIPI framework and associated technical infrastructure (databases, etc.) besides sheer building evaluation, **also** for the assessment and promotion of products broadly contributing to the IEQ. Important to stress, this point has also been clearly raised in the PERFECTION DoW.

As a **vision**, a commercial platform, built around the KIPI indicator set may emerge, providing a potential income source that may support the financial sustainability of the service and finance the maintenance and future development of the KIPI environment.

This document attempts to jointly highlight **what** will exactly be implemented as well as **how** this will be done. The service will be described from

- the **product provider** point of view
- the **service visitor** (potential product buyer) point of view

4.2. Product provider

Follows a description of the functionality that will be supported.

4.2.1. Provider registration

IEQ related product provider registration to the service will, **in all cases**, be required. Providers that will register to the service will necessarily be providers (manufacturers, traders, resellers, etc.) of products that clearly relate to IEQ. At this point, registrants will have to identify their activity and their products. However, no check will be made at this moment as to the relevance of the provider. This will only be made when they upload their product information (see downstream discussion) and not at this moment of their registration.

In addition, registration here should not be confused with the registration to the building assessment service, hosted at www.indoorperformance.net. The purpose of the registration to the product service will be to maintain a database of all IEQ product provider registrants; these may be then communicated and managed all together, be jointly sent newsletters, if they explicitly agree, etc.

Provider (IEQ product provider) registration will be designed to be a concise procedure that may **complete in just 1- 2 minutes and will come at no cost**. IEQ related product providers will also be allowed to upload a company profile and a logo. These will however be visible only after they publish, to the service, information on their products.

As a principle, though anybody may freely register to the service, provider information will only be visible if clearly associated to products of an obvious IEQ relevance.

4.2.2. IEQ product information upload (Not accredited section)

After providers have completed their registration, they will be allowed to upload product information. This information will include the following:

- Product name (obligatory)
- Photo of the product (optional)
- KIPI indicators affected (obligatory). A maximum value of three indicators will be enforced to secure rigorous descriptions. The indicators will be selected from the KIPI specification; free text entries of indicator names will not be allowed (*).
- Descriptive (free text) presentation of the way these we indicators are affected (obligatory)
- Descriptive (free text) presentation of the potential impact on the building performance, as coded in the KIPI indicator set (optional)
- Pricing information (optional)
- Contact point of the provider (obligatory)
- Product leaflet upload (optional)

(*) a product provider will always however be welcome to suggest a new indicator, if he feels he cannot easily assign his product to the KIPI set. The service provider may accept or reject this proposal, by means of its own internal procedures.

The following must also be noted:

- Providers may be **upload as many product descriptions as they wish**, by using the electronic template presented above, with exactly the same possibilities and restrictions.
- Just as provider registration, their **product information upload(s) will be free of any charge**.
- The **information published before going online will undergo a quality check**.
 - This check **will** secure
 - that no obscene, or otherwise inappropriate content is published on line. Related provisions will be clearly laid down in the *Terms of Use* on line document.
 - that the record truly refers to a product directly affecting IEQ
 - This check **will not** secure
 - that the descriptions entered by the product provider are accurate. In short, the service will not assume any responsibility for the claims made by the provider as to product properties, etc . This will be the sole responsibility of the provider and will be strongly emphasized in the service *Disclaimer*

Following approval, along the above prescriptions, the product records will be published on line and be made available to the visitors of the service. 1- 2 days will be enough time to secure the above mentioned controls. E- mail notifications will accompany the process (publication, upload approval/ rejection notification).

4.2.3. IEQ product information upload (Accredited section)

The accredited section of the service has exactly the same functionality as the above, not accredited one, with the **three important differences described below**.

1. The **content of the information published will be checked by the service** and only if found valid will be accepted for publication. The nature of this check will be described in a separate document (*Product Accreditation Principles*) that will be uploaded to the service, so that service visitors are fully aware of the information guarantee limitations provided by the service.
2. The **accredited product descriptions will not be freely published but will be subject to a fee** that will be defined between the product provider and the service and will be also be published to the service in a separate document (*Pricing policy*) for the information of providers wishing to upload their product information in the accredited section of the service.

3. **The accredited products will be published on line in a special, accredited, section that will precede the non- accredited, free, section.**

This dual functionality, serves the wide use of the platform (non accredited section) and secures potentially the financial sustainability of the platform (accredited section).

4.3. Product buyer

Visitors to the service will be able:

- to **freely browse** through all the service content (non accredited- free section as well as accredited-provider charged section); this includes all the product information published as well as all its provider related information
- to **search to find products that are impacting upon a given indicator**, that the visitor will select upon his interests.

In addition and **in order to secure an interactive as possible service, visitors will be able to publish their own requirements or requests**, which they **must however relate to a specific KIPI indicator** as the service will always be KIPI indicator driven.

Should a visitor wish to upload a specific requirement – request, he will be required to register to the service. This will again be a straightforward, 1-2 minute process, at no cost whatsoever. These requests will not be made available in the public section of the service. They will be available in the background, only to duly registered product providers. In addition providers will be able to request immediate email notification, as soon as a specific requirement, belonging to a specific KIPI indicator has been published to the background of the service. In this way a provider of security systems will logically express his interest for email notification whenever a relevant request/ requirement for such a system has been published by a visitor.

This allows very targeted communications and is one more mechanism to secure provider attraction to the service.

For service visitors there is no cost whatsoever. The service is and will forever remain fully accessible at absolutely no cost.

4.4. Other tool implementation details

The product evaluation tool will be implemented on the same on-line platform of the building evaluation one, and it could be accessed through a proper link on the building evaluation tool (<http://www.indoorperformance.net>), or directly accessed through the following address: <http://products.indoorperformance.net>.

4.4.1. User support

In order to help both product providers and final users to correctly and efficiently use this tool, some support mechanisms will be implemented. Some examples of these mechanisms are listed below.

- As the service will be based on the KIPI indicators **the full documentation available on the main KIPI site (see deliverable D 2.1- User engagement) will be available to the service users**, as it will allow an in depth acquaintance with the basic philosophy and content of the KIPI indicators.
- A Frequently Asked Question (FAQ) section will be added, in order to answer to the major questions regarding the use of the tool.
- Some support documents, including a *User Guide*, the *Terms of Use*, the *Product Accreditation Principles*, the *Privacy Policy* and a *Disclaimer*.

The user interface of the tool will be implemented in English. In the future, it will be possible to translate the user interface to other languages, provided that the partner requiring the addition will implement the translation. It is important to note the possible language selection will only apply to the user interface and not to the product related content published on line. Product information will only be in the language the product provider has selected and no automatic translation will be provided.

4.4.2. Charges

The **service will be financed:**

- by IEQ related product providers **wishing to have their IEQ related product accredited and presented in the relevant, first, section of the service.**
- by IEQ related product providers or any other third party that may **wish to advertise to the service.** A special area, to the left of the user interface will be reserved for these ads. Again, only relevant to IEQ ads will be accepted. The cost will be communicated in the Pricing Policy and the service User Guide.

It is again emphasized that **no fees will be collected for product description uploads in the free section nor for any visitor activity and service whatsoever.**

4.4.3. Property rights

The service will be maintained on APINTECH servers. As it has some commercial aspects, in the IPR document, the property rights of PERFECTIO key partners will be disclosed

The IPR document will take into account:

- the collective nature of the PERFECTIO project and the collective ownership of its results;
- the particular role and responsibility of APINTECH in maintaining and upgrading both the software platform of the tool and the hardware and software related of the servers hosting the tool.

In any case, **the business model will be that of a network model where many partners may participate, even in the same country.** If however a entity, from a given country, expresses its interest in becoming a network partner and at the same time, a partner already exists in the particular country, then **the interested part must also reach an agreement with the country existing partner.**

In any case, the **IPR document will include these provisions:**

- **Within the project lifetime and six months beyond that (till June 2012) It will provide to all PERFECTIO partners the priority right to participate to the service exploitation,** provided they will first provide, language adaptations of all the major support documents, defined beforehand in this document, as well as the user interface itself. This will be technically feasible, as the product service will be built on a technology supportive of internationalization (multi-language support). It is estimated that something close to 1 PM will be necessary to provide for this adaptation. This term is obviously applicable to any future network partner.
- **After June 2012, PERFECTIO partners may still express their interest for the promotion of the service in their countries.** They will however be on an equal footing with any other potential service network partner, expressing a similar interest. This means that if some other, outside the consortium, entity expresses its interest to deliver the service in its country, then it will be granted this right and **no PERFECTIO partner priority, may be possibly claimed at this moment in time.** Any other entity, from the same country, including PERFECTIO partners, will then have to reach an agreement with this network partner entity.

5. CONCLUSION

This document aimed at defining a toolbox for the evaluation of the performance indicators identified in the WP 1. The tool will take into account both the **building evaluation aspect** and the **product impacts** on the model. The **indicator list** that will be included in the toolbox is derived from the indicator framework developed in **T1.5**

First of all, an overview of the Key Indoor Performance Indicator (KIPI) framework defined in T1.5 is provided. The defined indicators are divided into three main categories: *Health and Comfort*, *Feeling of Safety and Positive Stimulation*, and *Accessibility and Functionality*. Each category contains a list of performance indicators that are further divided into technical indicators which could be measured and evaluated.

The indicators could be assessed into two different phases of the building life. They could be assessed considering the normal operations that are performed inside the building (**assessment in operation**), or they could be assessed during the design phase (**assessment in design**), when a new building is being built or is undergoing a renovation process. The indicators could be assessed in a simple way, by means of site visits, user surveys or reviews of design plans (**simple assessment**). However, for some indicators it could be useful to perform a more detailed assessment (**detailed assessment**), provided that additional information are available. Whatever assessment method is selected, the indicators are evaluated against a five performance level (from A to E, where A is the highest and E the lowest).

Some indicators defined in the framework cannot be applied to all the building types, thus a first estimation of the indicator impact on different building types is also provided (Σφάλμα: Δεν βρέθηκε η πηγή παραπομπής). The selection is based on the first case studies developed to test the indicator framework and the toolbox (office, school, residential, hospital and a place for temporary exhibition). Obviously, there are a lot of other possible activities inside buildings, and the impact on them will be analyzed during the next activities of PERFECTION project. On the other hand, many buildings host various activities with different requirements from the performance point of view. In such cases, the analysis must be separately performed for each activity area of the building in order to better provide to owners, managers and designers an indication of the critical issues. Σφάλμα: Δεν βρέθηκε η πηγή παραπομπής provides an estimation of the impact of the KIPI framework on the social, economic and environmental sustainability. The values indicated in the figure derive from a first estimation from the Consortium and could act as a basis for the discussion in T1.6, with the involvement of relevant Stakeholders.

The toolbox defined, based on an Excel sheet, and it is composed by two main sections: **General Information**, containing some general information in order to provide a synthetic description of the building under analysis, and **Indicator Evaluation**, with a separation regarding the assessment during the design phase and the assessment in operation. The Excel sheet also contains a column for each indicator related to comments. This column will describe the issue detected by user during the analysis and possible suggestions regarding improvement of the assessment methods. The current version of the tool is ready to use in real case, that could provide suggestions for the improvement of the tool itself. Suggestions could also derive from discussions and interactions with various stakeholders.

The document also provides a description of the methodology implemented to provide an evaluation of the products that could have an impact on the KIPI indicators. This section will be implemented on an on-line tool connected to the support tool for the building evaluation, and could provide an economical sustainability even after the completion of the PERFECTION project. In fact, the possibility of providing a payment section with accreditation functionalities will be investigated, in order to allow the product providers to advertise their solutions aiming at improving the indoor environment quality. The main part of the product evaluation tool will always remain free of charge, to provide a valid support to building owners, managers and designers that are searching the best products that meet their requirements in terms of indoor quality.