perfection

SEVENTH FRAMEWORK PROGRAMME

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

FP7 Grant Number 212998

D1.5 Annex A: Accessibility and Functionality

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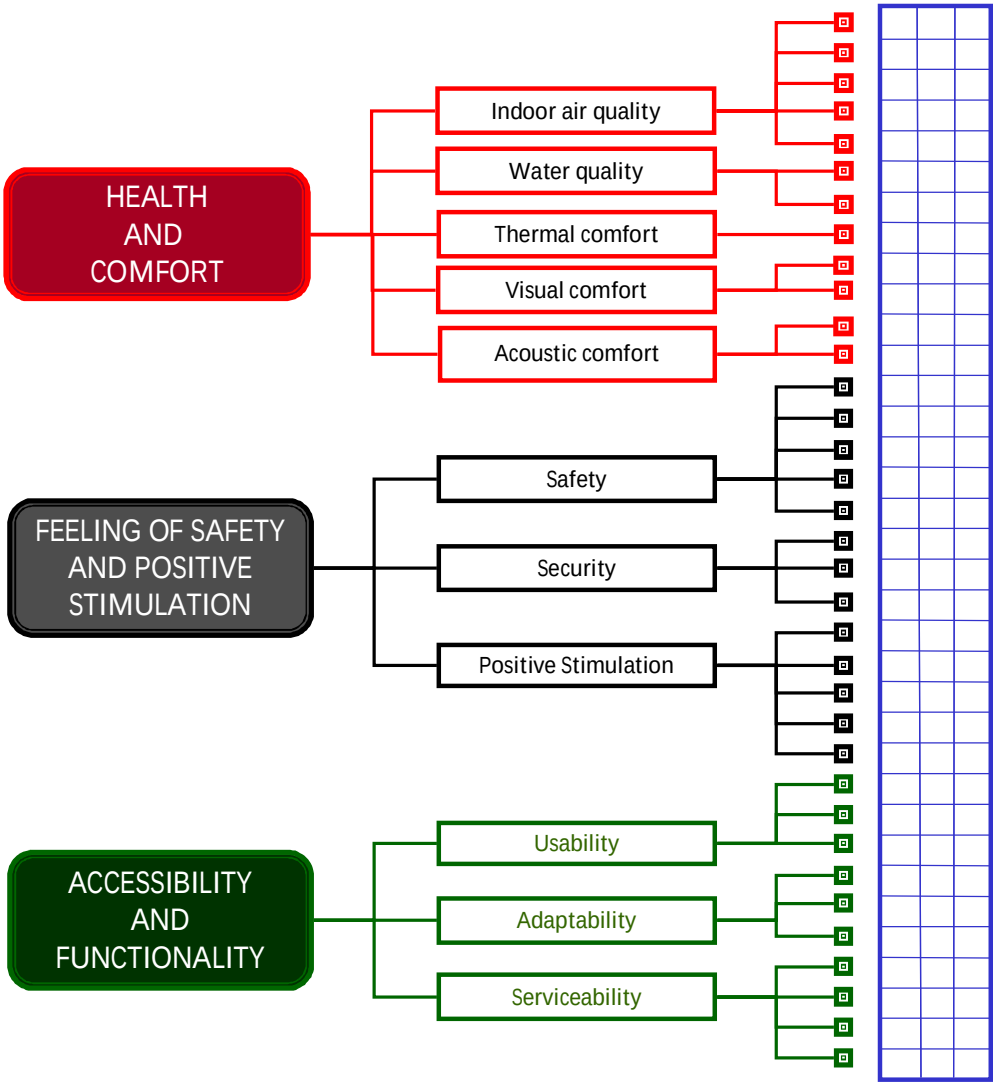
1. INTRODUCTION

This document "Accessibility and Functionality" describes indoor performance indicators that do not fall under "Health and comfort" (T1.3) or "Feeling of safety and positive stimulation" (T1.4) categories. The proposed T1.5 indicators are structured under the headings of usability, adaptability and serviceability.



When developing the Indoor Performance Indicator system further, and when selecting the Key Indoor Performance Indicators (KIPIs) one must bear in mind that some indicator sets are relevant in some building types, but also that some indicators are especially important only in some space groups or rooms within one facility or building type.

Perfection focuses on successful management of indoor performance of buildings. In some cases it is not easy to differentiate outdoor performance from indoor performance. The category of accessibility (inside the building) is not meaningful to discuss if the accessibility to the building is not in order. This means that Perfection contains an accessibility indicator to the building and accessibility indicators in the building.

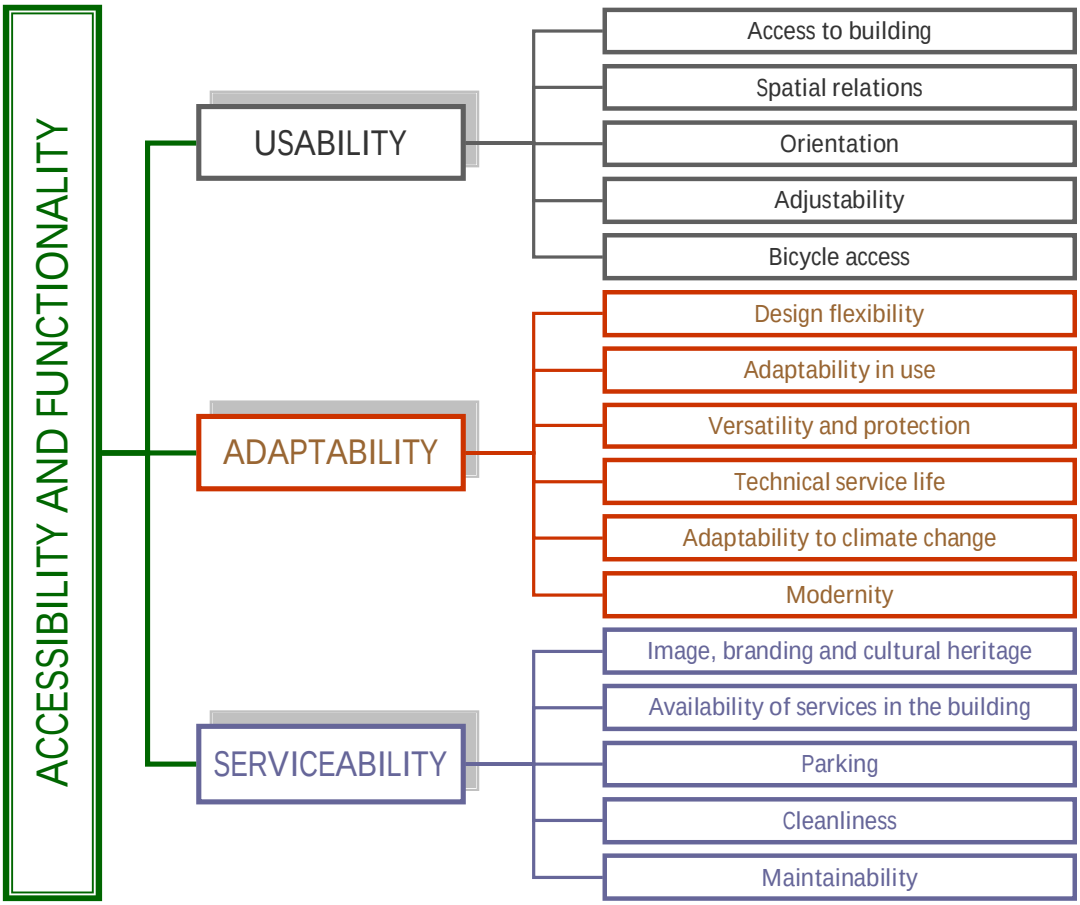
Parking spaces and their performance indicators are important in some building types (malls, offices etc.) e.g. from the serviceability point of view. Sometimes these spaces are located inside the building (heated, lit and ventilated spaces), sometimes attached to the building (covered at least partly), sometimes outdoors. It is not clear when indoor performance indicators should be applied for parking, and should it be tackled under accessibility or also serviceability.

In housing in the North, glazed balconies are very popular. When the glazing is opened, the balcony could be seen as outdoors, when closed indoors. The views is another aspect, e.g. in positive stimulation. Is the view to outdoors an indoor performance indicator?

2. SELECTED CORE INDICATORS

The proposed T1.5 indicators are classified under the categories of usability, adaptability and serviceability. Each of them has impacts to

- social sustainability through the performance and value they provide during their life time
- environmental sustainability through the use of nature's resources and emissions they create during their production, transport, construction, operation, demolition and end disposal
- economic sustainability as cost impacts in different phases.



2.1. Usability

According to ISO 9241-11 (1998) usability is the “extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” [4].

CIB W111 focuses on the concept of usability of workplaces including commercial buildings and buildings for healthcare and education [5]. “Usability, with focus on the user perspective, is often a neglected aspect of building performance” [2], but the importance is increasing as organisations seek new and more effective ways of working. Several aspects influence a building's usability. According to Hansen et al. (2005), usability, or functionality in use, is concerning the buildings ability to support the user organisation'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 focuses on user perceptions of the ease and efficiency with which they can use the building. [2]

Alexander (2006) states that usability is a time, place, context and situation bound concept the better understanding of which will be useful not only in evaluation of buildings already in use, but it also might provide relevant knowledge to include in the briefing process of design [6].

Jensø et al. (2004) have suggested that the concept of usability can be approached in four ways [7]:
1. Criteria and parameters affecting usability
2. Usability from different stakeholders' point of view
3. The time perspective
4. Workplace and context

Alexander's (2008) outline is composed by three aspects: user (knowledge, expectations and perceptions), facility (its characteristics and functions) and situation (tasks and goals) [8].

In order to better understand the concept of usability as a use process experienced by the users, Nenonen et al. (2008) propose a method called "customer journey" [9]. It consists of trying to understand user experience as a process by structuring, conceptualising and visualising the path the user usually passes through in the building. After the path is understood with help of different scenarios, the customer experience is investigated through surveys or interviews. The advantage of this method is that it seems to cover well the user experience in all types of situations that the user can be faced in the building.

2.2. Adaptability

In ISO/TC 59/SC 17 (2010) buildings' adaptability is defined as their "ability to be changed or modified to make suitable for a particular purpose. Adaptability includes aspects of flexibility and convertibility". [1] 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 [2]. [1] treats two aspects of adaptability: adaptability for changed use purpose and adaptability for climate change. Adaptability for changed use purpose contains the following aspects: the quality of space design, openings, capacity and building services. In this sense adaptability is especially relevant for office buildings being an important criterion of their value.

The adaptation of buildings stands in connection with the following partial goals:

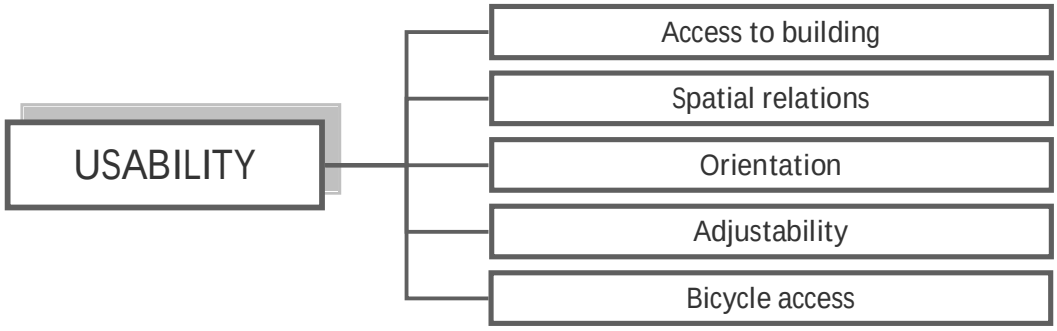
- to accommodate individual user requirements
- to accommodate the change of user requirements
- to accommodate technical innovation
- to accommodate the change of use.

Assessment in design phase and use phase can be done with help of expert assessment of the design, building and its options. Well designed adaptability saves environmental and economic resources. The adaptability of buildings is the prerequisite for a long utilization and service life and contributes to the avoidance of technical and functional obsolescence. A long utilization/service life of buildings offers advantages for the evaluation of economic and environmental performance during a simultaneous adjustment to the change of technical and functional requirements. [1]

2.3. Serviceability

Serviceability is defined by ISO 6707-1 (2004) as “ability to meet or exceed relevant performance requirements”[3]. [1] considers serviceability as being “the fitness for purpose and thus the ability of a building to fulfil the user requirements from the functional point of view”. In [1] it is limited to space design and information, and communication of technological services of the building in relation to the intended use and user needs. The indicator is a process related indicator the use of which requires that the process is described and classified in terms of the consideration of user needs. The assessment in design phase takes place by comparing the user requirements with the design and/or technical solutions. Measurement in use phase can be done with help of expertise and post-occupancy evaluation, and takes into consideration the required levels of functionality that are compared to the available levels of serviceability. The potential impacts are user satisfaction, value of the property and worker productivity. [1]

3. USABILITY INDICATORS



3.1. Access to building

This indicator encompasses the approach to the building and the entrance. The approach to the building is a set of basic design indicators which are checked in order to check if a disabled person is able to approach the building. If the disable person is not able to approach the building, it is nonsense to consider the accessibility inside the building. The entrance to the building includes any ramp and steps as well as the entrance door. The design of ramps and stairs is a complex matter and subject to specific requirements that are given in guidance documents. For more details see T1.4 chapters 3.1 “Approach to the building” and 3.2 “Entrance to the building”.

3.2. Spatial relations

This indicator addresses the usability of the layout and the spatial organisation of the building in relation to the functions or activities it houses. The aspects that should be considered include e.g. distribution of functions/activities, easiness of orientation (see indicator 3.2.), spaciousness, and clearness of layout to the function and use of the building. Also the user experience should be evaluated in terms of the usability of the layout, distribution of functions in the building and in rooms/spaces, and the sense of space in the building.

3.3. Orientation

People should be able to move throughout a building and use the facilities present without unnecessary assistance. The easiness of orientation is especially important in buildings that are not visited daily by the users, e.g. in hospitals. The indicator is also relevant for schools and office buildings. The easiness of orientation is affected by the quality of layout, space planning and spatial organization. The movement in the building should be made possible also for disabled (visually and hearing impaired included). In order to make easier the orientation of especially visually impaired, lighting and colour contrast (in fixed building elements) are important. For the services for hearing-impaired, see 5.1 “Availability of services in the building”. For more details see T1.4 3.3 “Movement inside the building” and 3.5 “Communication in buildings” (accessibility).

The easiness of orientation is affected e.g. by the following aspects:

- the visibility and vicinity of the main lobby from the entrances
- the visibility and vicinity of elevators and stairs from the lobby and entrances
- the visibility of main corridors

- the width and height of main corridors
- the clearness, consistency and quantity of signage
- the existence of information desk or directory board
- the availability of maps of the building
- materials and finishes of floor surfaces
- opening widths of internal doors
- lighting and colour contrast (between floors, walls and doors) assisting wayfinding and avoiding accidents

The ASTM standard "Location, access and wayfinding" (E 1669 – 95a, 2005) treats e.g. the following aspects of wayfinding in office buildings [14]

- staff visits to other offices: location of other offices visited during work; convenience of access to other sites
- capacity of internal movement systems: accessibility and wayfinding of visited spaces or offices by elevators, escalators and stairs; availability of convenient elevators for handicapped; convenience, width and pleasantness of corridors and stairs
- public circulation and wayfinding in building: separation of incompatible groups; wayfinding to elevators or stairs; wayfinding within building (how well visitors can find their way to relevant destinations, visibility and signage of reception areas from elevators on upper floors); separation of freight and passengers.

3.4. Adjustability

This indicator considers adjustability in terms of easiness of use of the building and the controllability of indoor conditions. The use of building may be complicated and therefore some of the key characteristics of comfortable environment are not met. Thus, the adjustability of spatial solutions, building automation systems and other important features of use are evaluated. [10]

The adjustability of indoor conditions such as temperature, humidity, ventilation, air-conditioning, lighting and entering natural light affect the comfort of occupants and are thus also important factors to evaluate. Another important aspect is the adjustability and ergonomics of workstation.

Some characteristics that may need special attention include

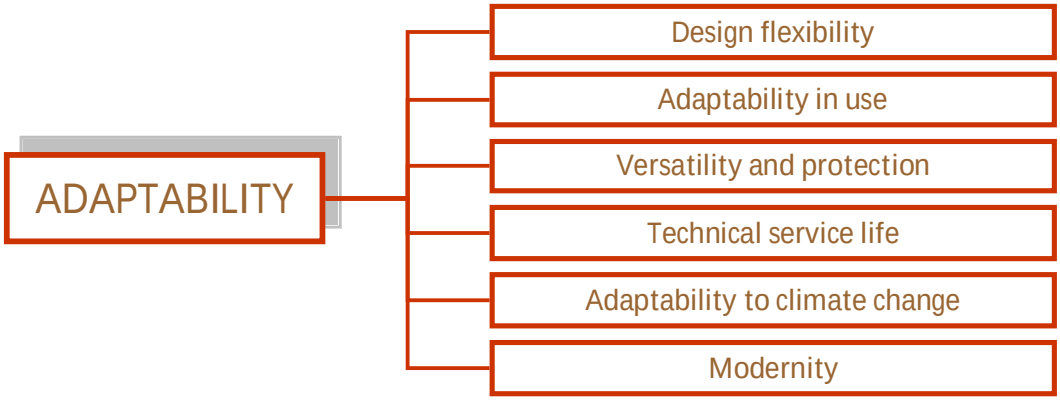
- controllability of temperature in enclosed rooms (e.g. bathroom)
- distribution of air-condition (is the level of air-condition too high or too low in some places or is it equally distributed)
- existence of unpleasant odours caused by ventilation (or mould or other unwelcome substances)
- controllability of solar light (existence, sufficiency and effectiveness of solar control devices)

This indicator can be assessed with help of POEs, user satisfaction surveys and interviews.

3.5. Bicycle access

Bicycle access is a relevant indicator in office buildings, schools and hospitals. In office buildings the availability of facilities which enable easy use of bicycles, such as showers and lockers, should be considered.

4. ADAPTABILITY INDICATORS



4.1. Design flexibility

Design flexibility describes the possibility of having different layout combinations in different floors of a building. It is especially important in new construction and refurbishment activities providing variety in floor plans. It requires good design. [10]

The use of this indicator requires that there is a system which describes the different levels of design flexibility. Assessment in design phase and use phase can be done with help of expert assessment of the design, building and its options. [1]

In this project, however, the indicator can be evaluated with help of a check list of structural properties including

- entrances
- structural width of the building frame
- ventilation system (HVAC zones)
- vertical ducting
- window openings
- division of spaces (security zones, indoor climate, partitions)
- lifts
- etc.

4.2. Adaptability in use

Adaptability in use reflects possibilities for changes in the facility to meet changed use needs. The use of the indicator requires that there is a system which describes the different levels of adaptability. Assessment in design phase and use phase can be done with help of expert assessment of the design, building and its options. [1] It is important to consider how well the objectives of the owner meet the needs of the users.

The criteria influencing this indicator include e.g. load bearing structures, bearing capacity, entrances, staircases, security zones. [10] It should also be considered if different layout solutions affect the acoustical or visual conditions of the space.

Another important aspect is furnishability. It considers the ability of easy furnishing in the building. The furnishability is affected by suitable dimensioning, type of the layout and the form of the building and its spaces.

The indicator is particularly relevant for office buildings [1]. In office environments important factors to consider include e.g. layout for efficient group work and for various group sizes, adjustability of illumination and HVAC for each workgroup and different layouts, and separation of workgroups. Open plan offices are more easily adaptable for changed needs than office buildings with individual workrooms.

4.3. Versatility and protection

Adaptability of buildings to meet changing needs of changing users is an uncontested criterion of its value. Considerations of potential second and following users may also add value especially to building owner. [10] This indicator addresses the building's adaptability to changing needs that stem from changing users or changing activities. [11]

The assessment of versatility can take place both during the design phase and use phase, and relies in both cases on expert assessment. The usability of technical solutions is assessed considering the needs of the first users but also the needs of possible future users. The structure of the building should allow different layouts. Important factors include therefore the structural width of the building frame, the organisation of rooms, corridors and modifications in the form of the building. The flexibility of the building should be considered from different perspectives: technical flexibility, flexibility in furnishing options and construction allowing flexible division of spaces [11].

For the assessment of this indicator a check list will be proposed. It consists of activities which are possible without major changes.

A special case of this indicator concerns the protection of buildings with remarkable cultural value (architectural, symbolic or historical). Maintaining and protecting cultural heritage is important in order to preserve the cultural values of the site or country. The conservation of that kind of buildings may increase the value of the property and add value to the users and the community. Major changes should not take place in those buildings. That kind of "non-adaptability" of buildings, considered being cultural heritage, may be also required by codes and regulation. The regulations concern construction and refurbishment activities as well as all the changes in the indoor environment of the building.

The assessment can be done with the help of experts or specific commissions.

4.4. Technical service life

The building, its systems and components have a planned service life that is assessed in years. The technical service life is defined as "the period for which a structure can actually perform according to the structural requirements based on its intended purpose (possibly with necessary maintenance but without major repair)" [12].

The service life of a given building structure is affected by the following aspects [12]:

- design of the building, its structure, joints and components
- quality of the individual materials and components
- standard of construction
- actions on the structures during life
- environmental effects on the structure
- the use and changes in use of the building during its service life
- the decision processes regarding maintenance, repair, adaptation and finally demolishing of the structure

CIB Master List (1993) proposes the following check list to consider in relation to service life [13]:

- effects of biological, chemical and physical agents, of conditions in use
- durability rating, vulnerability to decay
- resistance to abrasion, corrosion, acid or sulphate attack
- carbonation, alkali-silica reaction
- ageing, loss of solvents and plasticizers
- blistering
- creep, loss of flexibility, chemical and mechanical effects of cleaning substances
- light fastness
- loss of serviceability, deterioration of fail-safe mechanism

During its technical service life a building structure has to fulfil minimum performance requirements in two levels: structural safety and serviceability. The structural safety of a structure depends on the resistance and the solicitation of the structure. Both can be subject to seen or unforeseen changes in time. The serviceability of the building and its structure play an important role in the life of a building structure. Both the level and the requirements regarding the serviceability can change in time. Deflections and cracking may increase in time, even to such an extent, that serviceability criteria are no longer met. Specification of appropriate serviceability limits regarding deflections, vibrations or cracking etc. may change as well (partly depending on how they are perceived by the users). [12]

The evaluation of technical service life is done by expert assessment.

ASTM (2009) proposes a rating scale for anticipated remaining service life [14]. The facility is rated with a 5-grades-scale according to the points scored in the following table (table 1). The best level of remaining service life is achieved with at least 26 points, and the lowest level with less than 10 points.

TABLE 1: Anticipated remaining service life (source: ASTM, 2009)

Points	Remaining useful life at least: Equal to
3	Building envelope: seals, joints = 10 years or more
4	Roofing and flashing = 15 years or more
5	HVAC prime movers and main systems = 20 years or more
3	HVAC secondary distribution, for example, small fans = 10 years or more
4	HVAC controls = 10 years or more
3	Elevators and escalators = 20 years or more
4	Ceiling systems, including fixtures = 15 years or more
3	Interior finishes, for example, coverings = 10 years or more
3	Operable items, for example, doors, windows = 20 years or more
2	Other systems, for example, plumbing = 20 years or more
2	Site, for example, paving, sidewalks, etc. = 15 years or more
2	Electrical system = 15 years or more
2	Life safety system = 20 years or more

4.5. Adaptability to climate change

This indicator expresses the ability of the building to provide safe and resistant shelter for the users and occupants of the building and the ability to maintain the value of the property with reference to loadings that may become possible in the future because of climate change. [1]

Climate change may cause in the future phenomena such as rainstorms, flooding, earthquakes, storms, avalanches, mud flows, tornados etc. The possibility of these hazards affects the durability of buildings and needs specific efforts in building design.

The use of the indicator requires that the change of loadings because of climate change have been locally assessed. Measurement in design phase can happen with help of expert assessment and/or simulation of the design. Measurement in use phase can happen with help of expert assessment and/or simulation of the building model. [1]

4.6. Modernity

Modernity is considered as an indicator affecting the adaptability of a building in the sense how well a building can respond to the possible needs for change because of old-fashionedness.
Factors that can affect a building's modernity may include

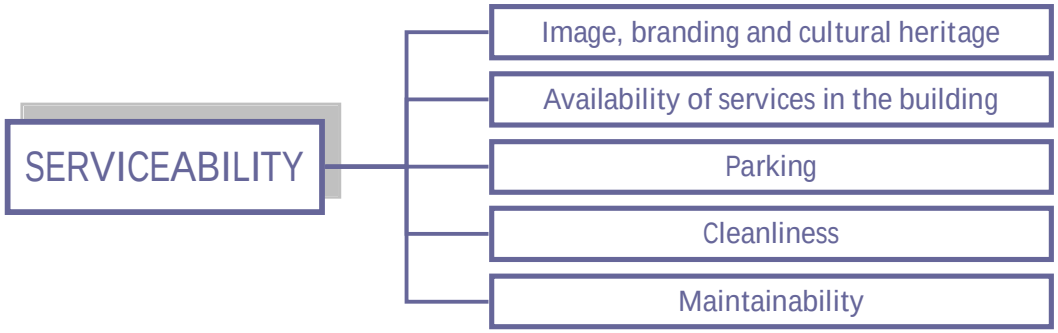
- the condition and age of building components
- the condition of surfaces, their finishing, wall covering and wall paint
- the condition, age and design of furniture, fittings and facilities
- architectural modernity
- design modernity including the colours in the building
- the modernity of technical systems

The indicator is affected by changing trends. To give an example, in hospitals in Finland today's trend is to replace sickrooms for several persons with individual sickrooms. Also the path a patient needs to follow in hospitals is tried to minimize.

Normally, this indicator is not relevant for historical buildings because their charm can be partly based on their old-fashionedness. More generally, buildings with remarkable aesthetic, architectural, historical or symbolic cultural value are usually not concerned by this indicator and the changes can be controlled or even prohibited by regulation.

The assessment is done case by case through expert assessment (architects).

5. SERVICEABILITY INDICATORS



5.1. Image, branding and cultural heritage

Image

The image of a building is a subjective experience which consists of several aspects. However, the first impression of the building seems crucial. Thus the importance of the entrance, the lobby and the general appearance of the spaces are emphasized.

Especially the architecture and design of a building may communicate a message to the public. White colours are used in hospitals in order to give the impression of a safe place. A well designed and modern school building may seem a better school than an old and decrepit school building. This indicator seems, however, the most relevant for office buildings in which the physical workplace is an important representation of the corporate culture. Corporate culture, image and messages communicated about the organization to employees and customers are well presented by the physical workplace [15]. The web sites are another important means affecting the image of the company, but as Steiner points out, "the workplace touches all five of the human senses" [15].

In the case of office buildings, the choices made in relation to this indicator are considered in organizations from strategic perspective. The building should communicate the values of the company. The image of the company may be reflected in the choices concerning e.g. design, layout, colours used, artwork, furnishings and plants, and architectural solutions such as form of the building, materials used (today often glass for its transparency), spaciousness of the lobby and natural light. Another factor is naturally the condition and age of the building and its components.

ASTM (2009) proposes a standard classification for serviceability of an office facility for image to the public and occupants (standard E 1667 – 95a, 2005) [14]. In this standard image is divided into the following categories: exterior appearance, public lobby of building, public spaces within building, appearance and spaciousness of office spaces, finishes and materials in office spaces, identity outside building, neighbourhood and site. Each of these sub-indicators of image contains a 5-grades-scale according to which an office facility can be rated. For example, public lobby is assessed according to the following criteria: general appearance, materials and condition, layout and spaciousness, interior signage and staffed information desk. The rating of public spaces within building, on the other hand, contains aspects such us image of public areas, public circulation routes and washrooms accessible to the public.

Branding

The branding of a company contains aspects of standard quality of work and the certificates of the building such as its energy efficiency, environmental impact or indoor climate. Some examples of well-known rating certificates are BREEAM, LEED, CASBEE, PromisE, SBA, Energy label and Green office.

From economic point of view, investors tend to prefer international certificates that are expected to correlate positively with the sales value. From the environmental point of view, locally adjusted rating systems are preferred. Current assessment systems do not reflect well the performance in use of buildings. [11]

In addition, commercial companies aim at developing a brand of the quality and values of their work. In this meaning, a brand can even be converted into money. The characteristics of a brand are logo and image and it is supported by marketing. In the commercial context World Trade Center and Nokia offer examples of strong standard brands. The workers of these companies have the possibility to work in the same standard conditions worldwide when travelling.

Cultural heritage

Maintaining and protecting cultural heritage may increase the value of property and is important in order to preserve the cultural values of the site or country [10]. The conservation of that kind of buildings may increase the value of the property and add value to the users and the community. The cultural value (architectural, symbolic or historical) of the building is considered if it is distinguished by remarkable qualities. [11] Buildings' cultural value has a positive effect on the image (or brand) of the occupants/ user organisation (e.g. buildings being landmarks of a style, time or country).

The indicator is a qualitative indicator. The assessment can be done with the help of experts or specific commissions. This indicator concerns mainly historical buildings.

5.2. Availability of services in the building

The purpose of the services in the building is to cover the needs of the users. The availability of services can have an impact on user satisfaction, economic value of the property and, in office buildings, on worker productivity.

The range of relevant services depends on the type of building. In the following, some typical services that may be relevant are listed according to the building type (office, school, housing, hospital, historical).

All the building types:

- sanitary facilities (availability, wheelchair accessibility, for details see D1.4 3.1.4)
- maintenance (see indicator 5.5. maintainability): management, janitorial services, HVAC, electricity, BAS-services…
- parking (see indicator 5.3. parking)
- cleaning (see indicator 5.4.)
- security and safety services: the needed variety and level of security services depends on the value (economical or data protection) of the assets and on the safety of the

neighborhood, ranging from basic door lock services to external guard agencies and other surveillance services using e.g. monitoring cameras

Offices, schools and hospitals:

- catering
- administrative support
- inventory, storage and procurement

Offices and hospitals:

- reception
- switchboard
- mail and delivery: mail sorting and delivering, internal mail system and other delivery services according to the needs

Offices:

- office supply and copying
- ICT services
- internal moving services
- gym
- showers and lockers

Housing:

- cables or/and antennas for radio, television and internet
- house manager and service man or janitorial service

Some services may be important to be provided also from the accessibility point of view. E.g. people with hearing impairment require assistance normally in the form of an electronic hearing enhancement system (induction loop, infra-red, radio systems). The presence of such systems requires signage (and assistance) for users. For more details, see D1.4 3.5 “Communication in the building”.

The services needed in historical buildings are difficult to categorise because of the variety of types and uses of historical buildings. In addition, hospitals need specific services according to their type. Also office buildings may need extra services which are not treated here.

The assessment criteria for services are quality, spectrum/range/amount and whether facility services are organized according to the generally accepted recommendations. The quality and range of services should be assessed separately in each building category. Assessment methods include post-occupancy evaluation and customer satisfaction surveys. Generally the quality of services is rather difficult to determine. Therefore it is important that the procurement processes follow some generally accepted procedures [10].

5.3. Parking

Parking possibilities affect the accessibility of a building. Therefore this indicator is also treated in T1.4 under the subtitle 3.1. "Approach to the building" of accessibility indicators. It is considered in the context of indoor environments because it is a prerequisite for the access to the indoors. However, in this context, only the parking places inside the building are considered.

This indicator addresses the standard and quality of the facility's car parking including vicinity, number of parking places, price and the level of sheltering.
The criteria of measurement may include some of the following:

- Quantity
  - number of parking units per gross floor area
  - parking places / users ratio
  - parking places / users or employees
- Vicinity
  - meters
  - minutes of walk
  - indication on a map
- Quality
  - indoors/ outdoors (%)
  - is it warmed or covered or is there a plug box
- Parking fee
  - yes/no
  - price.

The sufficient availability of parking places for handicapped must be provided in all cases and this is regulated by law.

This indicator is relevant for all the building types. However, the measurement must be done separately in each building category because the needs are different. This indicator is also country related because the need for warmed and covered parking places is more important in cold than warm countries.

5.4. Cleanliness

This indicator expresses the standard of cleaning in the facility in terms of work resources allocated to the cleaning, cleaning manual with the required level of quality described and quality control. Measurement classes may reflect work-hours /m², procedures on cleaning manual and quality control. This indicator is relevant for office buildings, schools and hospitals. The procedures and quality of cleaning need special attention in hospitals.

The ASTM standard "Cleanliness" (E 1671 – 95a, 2005) provides rating scales considering the cleanliness of e.g. the following surfaces, places and aspects [14]: building surfaces, fittings, fixtures and furniture; toilets and washrooms, other amenities; food facilities, computer centres and security areas; office waste, kitchen waste, garbage compactor and recycling

program. The ease of cleaning is considered in the standard "Manageability" (E 1701 – 95a, 2005) (type of surfaces and materials; fixture and furniture; condition; accessibility; waste handling; recycling).

5.5. Maintainability

The indicator is expressed in [1] as the quality of design, building and its structures and surfaces and the quality of maintenance plan with reference to 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 (a fault is the inability to function properly)" [1]. [1] deals with the maintainability from the viewpoint of the comfort of the users - the lack of maintainability resulting in the failure to function. The environmental impacts and life cycle costs of maintenance are assessed with help of a maintenance scenario and with help of LCA and LCC. The use of the indicator requires that different classes of maintainability are described. Assessment in design phase happens with help of an expert assessment of the design. Measurement in use phase happens with help of an expert assessment and interviews of the users of the building.
The potential impacts are

- social: satisfaction, productivity
- economic value
- environmental impact should be considered with help of indicators
  - depletion of non-renewable resources
  - use of renewable resources and
  - release of harmful emissions. [1]

The type, scale and timing of maintenance measures influence the building performance and thus also the life-cycle costs and profitability of real estates, and the comfort and productivity of the users of buildings. With help of good maintainability, and careful and systematic building maintenance it is possible to affect the comfort of the users of the building and the neighbourhood, preserving the existing built environment and related cultural value, economic value of constructive assets, and use of material and energy resources. [1]

The ASTM standard E 1670 – 95a (2005) about management of operations and maintenance considers the following aspects of maintainability [14]

- strategy and program: adequacy of budget; human resources; availability of replacement parts; maintenance contractors
- competence of in-house staff: training; cross-trade qualifications; electrical systems; electronic systems and controls; HVAC equipment; piping systems and repair; minor carpentry
- occupant satisfaction: actions to achieve confidence of occupant staff; actions to achieve confidence of senior management; response to surveys; outsourcing
- information on unit costs and consumption: database on O&M operations; comparison with recognized external standards and practices; knowledge of building operational parameters and their associated; use of information for effective O&M operations.

The standard on manageability (E 1701 – 95a, 2005) also provides rating scales for the ease of maintenance. The following aspects are considered: storeroom for maintenance, maintenance

workshop, maintenance contractors, availability of replacement parts, data for maintenance, painting and repairs.

6. DISCUSSION

This report has provided a review of indoor performance indicators that do not fall under "Health and comfort" (T1.3) or "Feeling of safety and positive stimulation" (T1.4) categories. The proposed performance indicators are structured under the following core indicators: usability, adaptability and serviceability. The indicators are organized in a way that overlaps between different categories could be avoided.

Some issues are listed here to be considered when applying these indicators e.g. in case studies

- buildings of multiple use (e.g. different functions in different parts of the building at the same time, different functions in the same building at different times of a day, different functions designed for the building in the future etc.)
- subjective assessment of indicators (users of building judging them) vs. objective assessment (quantified measures)
- the rationale behind subjective assessment (organisational aspects, personal issues etc).

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