The quality of indoor environment of intelligent building – global phenomena of sustainable architecture

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Abstract. The issue of intelligent buildings can be perceived in the context of creating an architectonic concept that accepts the requirement of sustainable development. The architect defines a development scenario for building intelligent buildings and a methodology for its implementation, in order to support the user of the intelligent building and to fully accept his requirements for intelligent buildings. The term “intelligent building” represents a well-designed, implemented and functional building that meets the requirements of operators and users and, above all, is able to satisfy the users and residents of the building. The intelligent building is built with state-of-the-art technologies and is equipped with progressive devices and systems. Despite the intelligent building concept’s focus on technology, a sustainable architectonic concept would play an important role in its creation. In the interests of architecture, the intelligent building is not just an exact reflection of the user’s needs. The architectonic concept provides the intelligent building with both sustainability and a high social and aesthetic value.

1. Differences between intelligent building concepts
The concept of intelligent building has originated parallelly in multiple countries. The differences that followed reflected the economic strength and growth, the social environment, cultural traditions and mindset of the inhabitants from these nations. The perception and importance of the intelligent building concept has been confirmed by the creation of institutions, ministries and state organisations, whose task was to create and adapt a concept for local requirements. These organisations formulated the definitions of intelligent building that would keep in mind the regional specifics.

Despite the different interpretations of the intelligent building concept in various countries, it is possible to name its sustainability as a generally recognised attribute. It is seen distinctively by the particular socio-economic environments of countries, such as adaptability and the energetic, ecological and economical sustainability of intelligent buildings (Figure 1).
2. The sustainability of the intelligent building concept in the USA

The USA can be regarded as the “cradle“ of the intelligent building concept. The reasons which have caused the progress of the concept were connected to the larger economic and political context. From the beginning a flexible construction has been part of the definition of intelligent buildings in the USA. It has been essential ever since the November of 1981, following the release of a certain article in the Engineering Digest magazine, which showed how steel frames and chamber steel ceilings contributed to the creation of intelligent buildings. [1] This focus on construction has as if survived until now in the American definition. According to the Intelligent Building Institute, the key sign of an intelligent building is construction which is designed to be adaptable to changes in an appropriate and cost-effective manner. An adaptable construction is one of the important articles of the American definition. Truly the only characteristic which all intelligent buildings have in common is a construction designed to be adaptable in an appropriate and cost-effective manner. Construction as the trait of an intelligent building is an irreplaceable criterion in the USA. The requirements made on the flexibility of areas are able to be realised directly by an architectonic concept and dispositional layout of buildings – without technological assistance. Therefore, the need of a flexible construction is the most vital criterion in the American definition.

The intelligent building directly adapts to the user’s needs through the architectonic concept. It is able to withstand changes and is subject to less moral obsolescence. The flexibility of construction has been a crucial attribute of the American intelligent administrative buildings ever since the 1980s. Tenants were often changed in administrative buildings in the US, and the new tenants’ disposition changes had to take place quickly and cost-effectively. Tenant fluctuation has become the driving force behind the creation of variable disposition intelligent buildings. This feature is a timeless and important criterion for evaluating intelligent buildings even today. The general characteristics of the adaptability of the architectural concept (flexibility, variability and elasticity) of an intelligent building can be seen as intelligent, showing the building's response to change - a sustainable solution. The intelligent building expert at the University of Reading in the UK, Derek J. Clements - Croome, also considered intelligent building responses to changing needs: "Intelligent buildings can respond to social and technological change and adapt to short-term and long-term changing human needs. This is the basic meaning of intelligent building.” [2] The response is also related to the ability of intelligent buildings to react to changes in the outside environment.
3. The sustainability of the intelligent building concept in Europe

Europe provides a different socio-economic environment for the creation of intelligent buildings than the USA. The European economy's market environment is not so firmly focused on achieving a return on intelligent buildings. Intelligent buildings in Europe are more focused on indoor quality. European Intelligent Buildings Group - EIBG (European Group for Intelligent Buildings), founded in England, defined an intelligent building in 1998: "It creates an internal environment that maximizes the ability of the building's occupants to function properly while at the same time enabling efficient resource management with minimal equipment and facilities costs during the life of the building."[3]

According to B. S. Brad: "The definitions of both the European Intelligent Buildings Group and the American Intelligent Buildings Institute are derived from performance and operational criteria with regard to comfort, adaptability, life cycle, cost and better control over available resources".[4]

Intelligent buildings are associated with the application of sophisticated operating systems to achieve cost-effectiveness and environmental performance. In the 1990s, the definitions of intelligent buildings in Europe were extended to many aspects related to the coherent link between users, building systems, and the environment. According to the European Intelligent Buildings Group (EIBG), an intelligent building should meet architectural criteria (high-quality intelligent building design, virtual building modelling, indoor quality, digital building design model) and other criteria (increased tenant comfort, health and safety, energy saving devices).[5] In doing so, it is not only about building new but also revitalizing interventions into existing buildings. "Revitalization is a change in quality that monitors the improvement of the performance of the interior while maintaining its original function".[6]

With its definition, the European intelligent building emphasizes the quality of the indoor environment in the building. An intelligent building provides more user satisfaction, energy savings, maintenance costs, and operating costs. A long-term sustainable intelligent building is a combination of high-quality architectural design and cutting-edge technology. The criterion for evaluating smart buildings by the European Intelligent Buildings Group is to consistently take into account the needs of users in developing the intelligent building concept. According to Andrea Caragliu, "European countries are emphasizing the role of innovation in the information technology sector, thereby providing tools to identify consistent criteria for building intelligent buildings."[7]

In this context, ambitious 2020 strategies have been set up to promote the energy sustainability of the European economy. These rules are the first decisive step towards a low-carbon, more secure, competitive and sustainable economy. These objectives are defined in the Energy Performance of Buildings Directive (EPBD) COM / 2016/0765 in order to ensure nearly zero energy consumption for all new buildings by 2020. Over the last 20 years, progress has been made in creating tools in Europe that play an important role in supporting and guiding the sustainable development of intelligent buildings. In Europe, effective tools have over time become the basis for building buildings that can deliver higher performance, perceived user benefits and long-term cost savings. According to Christy Du Plessis, who deals with sustainable development research: "In Europe, measurable building criteria are used that are built in accordance with a sustainable development model and provide the basis for measuring building performance."[8]

4. Coexistence with intelligent building

The concept of intelligent buildings combines the way of building process, but also the way in which the various functionalities in the building are controlled. For the user, perception is limited to the interactions that produce new user experiences (Figure 2). The goal of intelligent control systems is to allow a control of complicated hardware as easy as possible (therefore, the architecture must also have been physically adapted and reckoned with a new level of technical rooms, not just in large public buildings, but also in family houses or apartments). These systems are mainly taken from the USA,
where the intuitiveness of control a wide range of devices is a necessity. Intelligent systems also have a major impact on the interior of buildings, because control components of installations should be placed visible and accessible. "Intelligent installation, which is used to central control of the house and its parts, can be manifested in the interior by a central control panel, mostly placed on the strategically placed wall." [9]

Nowadays, the trend is to use applications in mobile devices (telephone, tablet or notebook), which are a control interface where we can by touch control various functions. We could mention as example the pre-setting of light scenes to enhance the dramatic of interior. Of course, the system allows you to control each lighting device individually, but concurrently there is a possibility to turn a staged atmosphere on command. Comfortable and aesthetic control is also applied in the residential environment, which is increasingly difficult to operate. Living space is no longer just control of lighting, heating and water, but it combines control of safety, entertainment, thermal comfort and also garden care and optimizes energy use. Another extension of intelligent control system is the so-called Internet of Things, which supports communication among systems and devices and increase the level of user comfort. Coexistence with the new systems of internal building management also creates curious situations where an automated system acts against user logic. For example, control elements of exterior jalousies correctly evaluate the threat of wind damage of them and, as a measure, they choose to retract the jalousies and turn them into a safe position. Paradoxically, by doing so, the whole building will be darkened during the day, which is not so sunny that. The sensors then evaluate that it is necessary to light up the interior devices and subsequently fails one of the greatest proclaimed benefits of intelligent systems: energy saving. Of course, this situation is an example of a non-tuning system, but it is also about adapting a person to new, unverified situations in a well-known indoor environment.

5. Conclusion
The concept of an intelligent building has a different meaning in Europe than the USA. It has been formulated in a close relation to the economic and social environment, the mindset of the inhabitants and cultural traditions. The European definition includes architectural criteria focused on the quality of the interior and the quality of the design. These criteria confirm the relevance of the architectonic concept in the creation of sustainable intelligent buildings in Europe. In comparison to the USA, they are more oriented towards the fulfilment of the user’s needs than the flexibility and return of the investment, which is the key requirement in the USA. Consequently, the sustainability of intelligent buildings can be perceived in larger relations connected to, with the exception of energetic and ecological requirements, fulfilling the user’s needs and the buildings’ long service life.
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