A SOCIAL APPROACH TO INTELLIGENT BUILDINGS

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Abstract: Intelligent buildings were a hot topic since the 1980's. The vision was to share building telecommunication backbones with energy management systems, fire alarms, security systems and even office automation. The benefits were touted to include cost savings for cabling and long term maintenance, plus a future potential for interoperability between systems.

The potential within these concepts and the surrounding technology is vast, and lives of users are changing from the effects of Intelligent Buildings developments on their living and working environments.

In other words, the main aim of building intelligent building is merely a technological trend. But using intelligent buildings has wider effects on users than intended. Neglecting the human aspects of the users may be considered as a shortcoming.

This paper considers the causes of this new trend in architecture in a larger social context, from which the rationalism of building intelligent buildings must arise. This will be done through exploring the concepts and applications of intelligent buildings, showing how all of them affect human life in such many ways.

1. Introduction:

Intelligent buildings apply technologies to improve the building environment and functionality for the benefit of their occupants or tenants while controlling costs. It also improves user safety, comfort and accessibility.

This piece of work will try to answer some questions that associated with the widespread use of the term “Intelligent Buildings”, that is:

- What signifies intelligence in buildings?

- Is the intelligent building better to live or work in?

2. Dilemma of the study:

Intelligence in every realm of our life is a way to make our life easy, comfortable and delightful. There is an increased interest from researchers in intelligence in buildings as equipments to fulfill the human physiological needs. But, unfortunately, this great interest faced by a shortage in studies that cover the psychological and social needs.

Intelligent buildings are constructed to be occupied by people, and these occupants form the reason for the existence of the buildings. Yet the viewpoints of occupants are not represented in the literature on intelligent buildings except researches done by VIT Building Construction Corporation in Finland on smart house features among 1000 tenants. It was found that all subjects have positive attitude toward living in intelligent buildings (Lehto, 2004).

This shortage caused by the difficulties to determine and realize psychological and social needs. So, this research will try to predict weather living and working in intelligent buildings accomplishes the psychological and social requirements of its occupants or not. Therefore, architects must take into account that conversion to intelligent buildings is not just a new trend in architecture but, it is a lifestyle transformation.

3. Research objectives:

AT&T established the concept of “Intelligent Building” in its office tower erected in Dallas by the year of 1982. This concept was first established with focal point on new intelligent equipments stuffed in that building.

After this time till now many researchers take the same point of view. They used to give an overview of existing and potential new services of the intelligent buildings and how these services may be designed and implemented using advanced IT (Christiansson, 2000).

Some researches pay the whole attention to the equipments implemented in intelligent buildings. On the other hand, there are some researches, which pay attention to human interaction with intelligent buildings (Fikry, 2002), but these researches didn’t devote to exploring all human aspects of intelligent buildings.

4. Research methodology:

This research is an inductive study based on the examination of the main characteristic features of intelligent buildings in light of their impact on the social aspects of the occupant's life. Therefore, our aim is to test two main hypotheses:

- Intelligent buildings have a significant impact on the life of their occupants.
- The intelligent buildings offer excellent environments to live in.

This will be done through two main parts the first is theoretical dealing with the intelligent buildings its origins, definitions, nature and systems.

The second part is dealing with the human needs and their existence in the intelligent buildings.

5. Characteristics of Intelligent Build ings (IB):

A few years ago the concept of Intelligent Buildings (IB) was considered futuristic and fanciful. Now they are reality. There are too many definitions of Intelligent Buildings. These definitions hold opposing views according to the profession of who formulate the definition.

To the user, an intelligent building offers economic and efficient environmental systems: heating, lighting and air conditioning. Also, it enhances safety and security. Moreover, it improves business potential with integrated data communication systems. To the manufacturer, intelligent buildings offer a profitable market, particularly if they are able to exploit both the commercial and consumer markets (McClelland, 2001).

As the wording, Intelligent Building suggests the building should be capable of making "intelligent" decisions or respond "intelligently" to changes. In a recent survey on Intelligent Buildings in Asia, the Republic Plaza down town Singapore was subject for a closer look. It was presented as being an Intelligent Building with the following project mission: "A built environment, which can be customized to support human activity under varying conditions" (Bjorkdahl, 1999; Ivanovich, 1999).

Smart home or intelligent home are the terms commonly used to define a residence that uses a control system to integrate the residence's various automation systems. Integrating the home systems allows them to communicate with one another through the control system, thereby enabling single button and

voice control of the various home systems simultaneously, in pre-programmed scenarios or operating modes (Mills, 2001).

Many researchers have criticized the purely technological definition of intelligent building. Intelligent Building Institute put forth the following definition: "the IB is the building which provides a productive and cost-effective environment through optimization of its four basic elements which are:

- Structure,
- Systems,
- Services,
- Management and the interrelationships between them. Intelligent Buildings help Owners, Property Managers and Tenants realize their goals in the areas of cost, comfort, convenience, safety, long-term flexibility and marketability (figure 1).

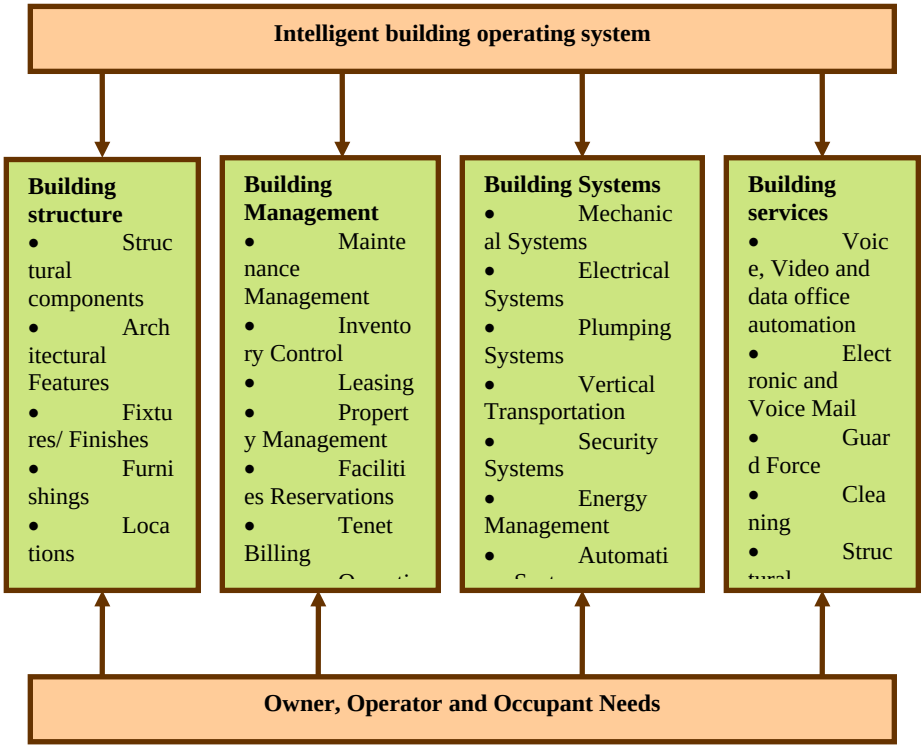

Figure 1 Intelligent Building Systems Affects Occupants

In details, the Intelligent Building is the building, which:

- Was designed and constructed with intelligence and talent—a building that's secure and safe.
- Can automatically adjust to naturally varying light, temperature, and humidity changes.
- Occupants can customize themselves to individual preferences.
- Operates efficiently and assists with its own maintenance—a building of distinction that reflects its owner's character.

An Intelligent Building is one equipped with the telecommunications infrastructure that enables it to continuously respond and adapt to changing conditions, allowing for a more efficient use of resources and increasing the comfort and security of its occupants. An Intelligent Building provides these benefits through automated control systems such as: heating, ventilation, and air-conditioning (HVAC); fire safety; security; and energy/lighting management. For example, in the case of a fire, the fire alarm communicates with the security system to unlock the doors. The security system communicates with the HVAC system to regulate the flow of air to prevent the fire from spreading.

Continental Automated Buildings Association (CABA)∗ defines an IB as: "A building and its infrastructure providing the owner, operator and occupant with an environment that is flexible, effective, comfortable and secure, through the use of integrated technological building systems, communications and controls."(McElwan, 2002).

This means that, ideally, a building is judged intelligent when the building subsystems provide the occupants with productive and comfortable conditions by responding to and enhancing the workplace environment.

Finally we can summarize the previous definitions in one comprehensive definition that is: The intelligent building is the building which is better to live or work in rather than it's the building which is designed with people in mind.

6. Responsiveness of Intelligent Buildings to human needs:

Perhaps the most important business driver for intelligent buildings is the ability to reduce cost, optimize manpower utilization and improve service levels by the use of latest technologies in building management to control environment, access, safety and costs.

The use of these technologies opens up for a multi-present presence in architecture (as well as in other places), which gives a new spatial temporal

∗ North America's Home & Building Automation Association

context to a given space: By entering this space you actually also enters a much wider spatial environment that allows you to connect with the rest of the world, gain information that have value to you in your present surroundings or lets you act back upon the physical space by changing it to soothe your need, potentially.

Architects used to consider the following characteristics of the interiors of the building in order to define it as an IB (Coggan, 2004):

1. Provide Spatially Flexible Environment
2. Provide Individually Conditioned Environment
3. Provide Individually Connected Environment
4. Provide Social Environment
5. Provide Healthy Environment
6. Ensure Low Energy/Low Resource Environment

On the other hand, Psychologists often deals with human needs through five main categories, they are:

1. Physiological: hunger, thirst, bodily comforts, etc.;
2. Safety/security: out of danger;
3. Belonginess and Love: affiliate with others, be accepted; and
4. Esteem: to achieve, be competent, gain approval and recognition.
5. Aesthetics

From the above it can be obvious that in order to grasp features of individuality and sociality, the IB must be flexible and adaptable. Flexibility secures the appropriate environment for diverse needs while adaptability is to hold changes in needs or occupants. The third main feature of IB is cost efficiency, which is a sustainable feature of the IB. These previous features are devoted to physiological needs. It's noticeable that safety and security are easily achieved in the IB. The psychological needs of belonging and esteem are factors of individuality, they have directly proportional relationship.

The proceeding part of research will study the responsiveness of intelligent buildings to the main signified human needs, both physiological and psychological, in the built environment

5.1. FLEXABILITY:

IB design focuses first on flexibility. That means reconfiguration to suit changing layouts limited by time and space needs. Flixability can be achieved easily with full modular infrastructure support. These infrastructure must be integrated across a modular pattern plan (Figure 2), determined by stackable, storage wall systems, Floor based furnished with modular work surfaces.

Swiss Re Building, London (Figure 3) is a good example of the feature of flexibility. The structure of the Swiss Re Building consists of a central core and

a diagonal grid perimeter. The core of the tower acts only as a load-bearing component, and it is free from diagonal bracing, this will produce a more flexible floor area. The diagonal grid perimeter is a grid of diagonally interlocking steel pieces (Laitnein, 2001).

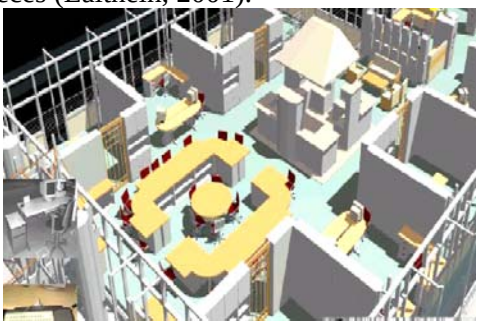

Figure 2 Modular pattern plan

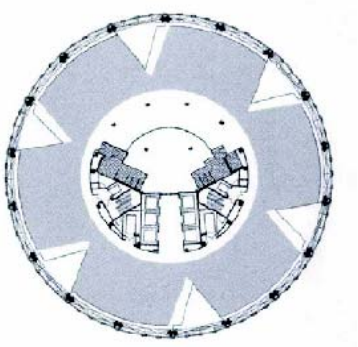

Figure 3 Typical Floor Plan, Swiss Re Building, London (Laitnein, 2001)

Figure 4 Removable light walls, Museum of federation square Melbourne – Australia (its official home page)

5.2. ADAPTABILITY:

Intelligent Buildings use technology to adapt to the needs of their occupants mainly physiological needs. The human needs differ from person to another. They also, differ according to sex, age and mentality. Adaptability is extremely important, since the building's support infrastructure can quickly become obsolete if it isn't planned with the future in mind (Jack, 2002). Notice that, adaptability enhances flexibility and vise versa

5.3. COST EFFICIENT:

One definition, which resulted from the International Symposium on the Intelligent Building, which was held in 28-29 May 1985 in Toronto, Canada, is: "an intelligent building combines innovations, technological or not, with skilful management, to maximize return on investment." (Coggan, 2004).

a) Natural light and ventilation into the core of the tower. b) Double glass

Figure 5 Cost Efficient in Swiss Re Building, London (Bridwell, 2000)

The Intelligent Building concept recognizes that the true cost of a building is not simply its cost of construction; it must include operating and maintenance costs over the structure's life span. Intelligent Buildings yield cost reductions in all of these areas by optimization automated control, communication, and management systems. They also guard against repair costs, employee time/productivity loss, revenue loss, and the loss of customers to competitors.

By turning off unnecessary lights and not heating unoccupied rooms, for instance, these buildings can reduce utility bills by %20 to %30 (IBpress2004).

Also, by intelligent solutions a building can considered as IB. The exterior of the Swiss Re building' London clads in glass. The glazing over the office areas have two layers of glass with a cavity, which will be ventilated by the used air

drawn from the offices. The glazing over the light walls consists of simple operable and fixed double glazed panels with tinted glass and a high-performance coating to reduce the penetration of solar radiation (figure 5).

5.4. PHYSIOLOGICAL COMFORT:

Comfort is one of those catch words that is easy to use and hard to define. A century ago comfort was judged very differently from now, because of expectations fueled by advances in technology. Back then, large windows were important for delivering light and fresh air. The primary objective was productivity, not comfort. Occupants need light to see their work and reduce accidents, and fresh air to keep them awake. Comfort is now being measured in terms of ergonomics, which seeks to decrease discomfort by reducing heath risks (McElwan, 2002).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Comfort Standards recognize the non-deterministic aspects of this relationship by making a distinction between thermal sensation, 'a conscious experience', and thermal comfort defined as a 'state of mind'. In other wards, the feeling of comfortable is a state of mind dependent on physical sensations (physiological) and emotional states (Psychological) (Morrow, 1995).

The comfort environment plays a major role in efficient performance of all occupants. The environment can be considered in three main components:

a. Thermal Comfort (Temperature, Humidity)
b. Illumination (Lighting)
c. Acoustics (Sound) & noise control

The most important variable which influence the condition of thermal comfort are: Air temperature’ Mean Radiant Temperature’ Relative Air Velocity’ Activity Level (heat production in the body), Thermal resistance of the clothing’ Water Vapor Pressure in ambient air.

The lighting comfort for tenants depends on level of direct light (Illumination) from the light source, coefficient of reflectance of floor, wall and ceiling, visibility, age and sex. Figure (6)

Figure 6 Controlling the amount of day light by motorized window coverings

The variables that affect the human comfort for acoustics are: background noise' level of Intermittent Noise, sensory of hearing, age and sex.

Thermal comfort is highly subjective. Not only is it subject to personal preference and acclimatization, but internal and external temperature sensing is integrated such that the overall sensation may be pleasing or displeasing depending on whether the resulting effect is towards or away from the restoration of deep body temperature. A cold sensation will be pleasing when the body is overheated, but unpleasant when the core is already cold. At the same time, the temperature of the skin is by no means uniform. As well as variations caused by vaso regulation there are variations in different parts of the body, which reflect the differences in vasculation and subcutaneous fat. The wearing of clothes also has a marked effect on the level and distribution of skin temperature. Thus, sensation from any particular part of the skin will depend on time, location and clothing, as well as the temperature of the surroundings.

Enhancing tenants' comfort it is in fact, a computerized energy management system. Tenants can program each room to his individual desire, expecting complete temperature control accuracy regardless of extra inputs/changes, e.g. sunlight, people coming and going, windows opening and closing, you name it. Smart Rooms Comfort Controller also has built-in sensors to effectively monitor the operation of each area. If that isn't enough, with the appropriate connections, you can remotely control a total environment by telephone or Internet connection.

A healthy environment of this kind can assist staff in keeping their concentration levels high, so contributing to productivity. To complement access floor air-conditioning and provide an integrated, intelligent office design, there are a number of compatible accessories such as partitioning, up lighting, cable management, power poles and floor panels of standard and high fire resistant construction. Even so, truly intelligent building design should not be regarded as

stemming from product ranges but rather from a whole methodology of coordinating complementary and flexible components (Thomas, 2002).

To improve building comfort to a satisfactory level is to provide a means of individual thermal control to every building occupant, and to accomplish that each occupant must have some connection to the building's comfort system.

In a survey made by Automated Logic Corporation, which is a corporation that provides cost-effective, user friendly building control solutions, it was found that comfort ranks first in importance on building owners' as well as the occupants' wish list (Hartman, 2000).

5.5. OCCUPANT PRODUCTIVITY:

Occupant productivity is highly linked with comfort. Environment affects comfort, which affects human performance, which affects productivity.

The building environment affects the well-being and comfort of human in the workplace, and in turn it influences human’s productivity, morale and satisfaction (Wong, Li and Wang, 2004).

5.6. INDIVIDUALITY:

When dealing with individuality we will find two sets of psychological needs related to it, which are often in conflict with one another. The two factors are: the need for personal autonomy (privacy) and the need for a psychological sense of community. New ways of communications may enhance our relations with distant persons but they may diminish our relations with the neighbors.

Figure 7 Individually controlled personal environments, Phillip Burton Federal Building

Personal needs change with task, age, gender, and many other factors. The net result is that providing a 'neutral' or 'optimal' environment is not possible. Instead, designers need to provide an appropriate range of response and a means for users to customize their space to meet their needs (Morrow, 1995).

Large zone HVAC and lighting must be broken into office-sized zones with personal controls provided. There are issues of open vs. closed space, degree of control, and personal perceptions.

5.7. AESTHETICAL NEEDS:

Aesthetical values of any building are a fundamental theme in human reaction to the built environment. In intelligent buildings this fundamental theme becomes more important since the abstract external appearance of an intelligent building is intended as a metaphor of information age. Also, intelligent architecture is always symbolizing futuristic features. Futuristic symbolism ranges from reasonable futuristic to fantastic futuristic symbolism.

Figure 8 Museum of federation square – Melbourne – Australia (its official home page*)*

7. Results and Conclusions:

- The comprehensive definition of intelligent buildings must comprises the human aspects of architecture.
- Building's user must have a say in the development of the construction and this idea is getting through to those responsible for urban planning and community development.
- Intelligent buildings will offer healthier environments to their tenants and they will raise their accupants' productivity.

- The IB must be flexible and adaptable in order to consider it as an IB. Since, personal needs change with task, age, gender, and many other factors, the intelligent building must be adaptable to all these changes.
- Enhancing tenants' comfort is, in fact, the most important gain from living or working in the IB. This comfort must comprises all the human requirements including physiological and psychological

Finally, we can conclude that:

- Intelligent buildings have a significant impact on the life of their occupants.
- The intelligent buildings can offer an excellent environment to live in.

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