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Assessment of Minimizing the Environmental Functions Conflict in Buildings

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Abstract

Some building components are responsible for achieving more than one environmental function, these functions are usually of different requirements that can never be done by the same actions, and they are usually connected to changeable internal and external environment characteristics that vary among them. Minimizing the conflict of achieving the different environmental functions is an important challenge for all designers. Achieving a continuous thermal and optical comfort in an internal building space using the same window is an example of this challenge, as they have different requirements that may be sometimes contrary. It should be notable that there are a lot of recent technologies that may be used to find solutions for such a conflict. The Environmental Assessment Methods of Buildings appeared to set the principles of the optimum relation between buildings and their environment, they also could be used to encourage designers to reach the best environmental relations, and award them by main or additional assessment points. The research paper proposes to use the Environmental Assessment Methods of Buildings to assess the building ability of minimizing its environmental functions achievement conflict. This proposal depends on determining the inconsistency assessment items that depend on common building components to be achieved, and then determining the time periods that these items are achieved together within, to indicate the time periods without conflicting. Thus, the paper aims to raise the building environmental value in the assessment when the designer succeeds to minimize the expected conflict of the building environmental functions.

Keywords

Human Comfort, Environmental Assessment Methods of Buildings, Periodical Variables, Sequential and Sudden Variables, Building Functions Conflict, Building Automation and Control

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1. Introduction

Building designers may decide to overlook some environmental functions within their buildings to achieve other functions that are inconsistent with the first ones, this happens when each of them has different and sometimes opposite achievement requirements, and when these functions depend or use the same building components to be achieved. Thus, if the appropriate building components' characteristics to achieve certain functions for the longest time are chosen to be used, they properly may not be suitable for the other environmental functions that use those components to be achieved [1]-[3]. The proper materials and forms to achieve the different building environmental functions are sometimes extremely different from each other, although they are all important to be achieved [4] [5]. Designers are then demanding to deal with the contradictions of the environmental functions over the time, and to find the outmost solutions to achieve most of the environmental functions through the longest time periods before a conflict of achievement appears among any of them.

Many researchers presented the problem associated by the accrued confliction and contradictions among the different environmental functions of the buildings. These researchers emphasized the great recent potentials to determine and minimize that problem, some discussed the use of smart technologies, and others presented the use of developed materials. Dounis *et al*. [1] focused on the energy and human comfort confliction when using the conventional control systems in buildings, then presented the intelligent control systems used to improve management of indoor environment, including user preferences for thermal and visual comfort, indoor air quality and energy conservation. Yang *et al*. [2] discussed the intelligent control of buildings using a multi-agent based control framework to fulfill occupants' needs and manage the conflict between the energy consumption and the comfort level in a building environment. Kang *et al*. [3] evaluated the optical and thermal performance of dye-sensitized solar cells (DSCs) windows in buildings, which helped to minimize those functions' confliction. Kim *et al*. [4] discussed tuning control of buildings glazing's transmittance that depended on the solar radiation wavelength to optimize daylighting and building's energy efficiency, concerning the variability of the solar radiation spectra incident on the building's envelope, and the variability of outdoor and indoor air temperature differences. Huang *et al*. [5] proposed a silica-aerogel filled super-insulating glazing system to achieve a more comfortable indoor environment while still retaining a low energy consumption level, which helped to achieve a longer thermally comfortable period than the conventional single clear glazing, and reduce the glare effect and near-window bright zone, while the indoor illumination level still met the requirements.

Few researches discussed the way to assess the building ability of overcoming the conflict problem among the environmental functions in buildings. Wong *et al*. [6] presented the development of a conceptual model for the selection of intelligent building systems which aimed at assisting the decision makers to select the most appropriate combination of intelligent building components, to choose between the myriad of intelligent building components or products in the market, as it became significant and crucial in the configuration of building alternative. Bluyssen [7] discussed the need for a different or at least an adapted approach towards evaluation of health and comfort of occupants in the indoor environment, he presented an integrative multi-disciplinary approach, taking account the positive and negative stimuli and concerned with "real" needs of people.

Considering the recent and rapidly technologies and potentials of controlling the building functions, this paper was looking for encouraging building designers to reduce the environmental functions achievement' conflict through their work, therefore, it proposed to assess the designers' ability of avoiding the functions confliction over the time. The paper depended on the widely used environmental assessment methods of buildings to include the proposed concept, which might help that issue to be easily spread, notable and attentional. The paper suggested a way to identify and determine the time periods that the environmental functions' confliction happened within, and then awarded points according to the intersected time periods of achieving them for the assessed building.

2. Environmental Functions of Buildings

There are numerous environmental functions are required from buildings, they are responsible for remaining the surrounding ecological system within a balanced ranges, avoiding any harmful emissions or pollutants into its internal or external environment at any of its life stages, remaining a zero life-cycle of its materials and resources (energy, water, etc.), meet the diverse balanced human needs, and others. In this paper, to discuss the confliction problem among the buildings environmental functions, it was focused on the human needs' functions, as they are easier to be recognized, but it should be notable that all the other functions should be taken in con-

sideration beside the human needs. The human needs are balanced in their normal conditions, and buildings are responsible of remaining them in their balanced ranges in spite of the continuing affecting variables. Man feels comfortable when equilibrium is achieved between the inside and the outside of the human body. Human needs are one of the following: physical, chemical, psychological, and radiological [8]-[11].

The human physical comfort is achieved when the person stays in a balanced state (thermal, visual, acoustical) to be able to do tasks without any stress. There are limits of physical balance, which are common for most people, thus when exceeding these limits the rate of a person's work will be affected leading to exhaustion and additional wasted energy. The building helps in influencing human physical requirements by affecting those limits, for example, it helps achieving thermal comfort by providing climatic suitable conditions in terms of temperature, humidity, and ventilation. It can also help achieving acoustical comfort by providing an appropriate voice level, and helps achieving visual comfort by taking into account the acceptable levels of luminance for different types of working activities (Researcher using Ref. [10] [12] [13]).

Human has an internal chemical balance related to his body temperature and organs activity, a negative impact on that balance appears in the form of illness. Metabolic is one of the chemical reactions in the body. The human chemical balance is affected by the different inputs to the human body, and the body cells should be able to get rid of any received toxins and pollutants to maintain that balance. People spend most of their time indoors, and studies have shown that the levels of pollutants in the internal spaces are three or more times higher than the outside. Buildings are responsible of reducing the different harmful chemical elements in the indoor spaces such as air pollutants and dust, besides helping the provision of the important chemical elements such as fresh oxygen. A human being has a psychological balance expressed in his response actions and behavior, which helps him in interacting subconsciously with the surroundings. Psychological equilibrium limits vary from one person to another; however, there is a range of psychological satisfaction determined by psychologists. Buildings are responsible for meeting some of the human psychological needs such as security, privacy, need of forming relationships, the ability of controlling the surrounding environment, sense of beauty and its perception, and so on. Buildings are responsible also for achieving a coexistence with nature which leads to a constant feel of connecting, interacting, and belonging to the nature. These requirements may vary amongst individuals and groups, and the absence of any of the human psychological needs leads to mental balance losses and prevents human interaction and responsiveness with the environment (Researcher using Ref. [10] [13]-[16]).

The human body is in a radiological balance in the normal conditions, but it may be affected by the electromagnetic fields of high-pressure wires in the surroundings directly and quickly, it is also influenced by the presence of radioactive waves of building devices such as computers, televisions, microwaves and others. A human has a continuous movement of charged ions through his body fluids and cells, and the human body contains a ratio of between 70% - 90% of water, so it is considered a good conductor for electricity, and it is influenced by the surrounding ratio of ions in the surrounding atmosphere. Building can affect the radiological balance of the human body by controlling the various ions ratio through its spaces and the radiation doses that the building contains and the human body receives (Researcher using Ref. [10] [13] [14]). From the previous, buildings are responsible for balancing the main four human needs within acceptable ranges, and achieving these four main needs are considered main environmental functions of buildings.

3. Confliction of Achieving the Environmental Functions of Buildings

The environmental functions in buildings depend on the buildings components' characteristics to be achieved, the building materials characteristics for instance controls the internal thermal, acoustical, and visual human comfort. Each building component (walls, roof, ceilings, windows, skylights, photocells, louvers, etc.) may affect more than an environmental function. The most obvious building component that is responsible of multi-environmental functions of different characteristics and achievement requirements are windows, as they are responsible of providing the natural light internally, minimizing or maximizing the solar heat gain according to the changeable thermal needs over the time, preventing the external noises from passing into the internal spaces, preventing the dust and the external pollutants from passing to the internal spaces, providing natural ventilation and fresh oxygen for the building users within limited speed and renewal rate, providing the sun rays with their important ultraviolet radiations into some spaces at the morning, providing the users by natural views to connect them by their nature to maintain their psychological balance, preventing the harmful electromagnetic radiations from passing to the internal spaces, etc. It is notable that the functions required from the windows cannot be

compatible with each other, they are so different in their requirements, characteristics and time relations, thus, each of these functions need different treatment through the different time periods that are required from the same building component. Thus, an extremely confliction among the environmental functions of buildings appears if the designer did not put in his mind to treat the conflict relations between the required ones from each building component before achieving them (Researcher using Ref. [1] [4] [5] [7] [17] [18]).

When focusing on the previously mentioned environmental functions of buildings, which are achieving the physical, chemical, psychological and radiological human balances, the conflict of their requirements are notable obviously. Using an atrium for instance, may affect the physical thermal and acoustical requirements in opposite ways, as it may cause a sound resonance and problems in sound transmission while helps a cross ventilation and shading effects. Using an appropriate area of photocells on the roof to produce energy in a hot climate may affect the thermal comfort requirements that prefer the reduction of solar gain and the use of roof garden or shelter for example. Minimizing the envelope area to achieve a thermal comfort affects the need of natural light and ventilation through the internal spaces. Using Air conditioning to achieve thermal comfort affects the chemical and radiological human balance that varies according to the devices characteristics and their periodical maintenance. Using barriers to protect people from a very hot or cold climate to achieve a thermal comfort separate them from their nature, which affects their psychological balance. Using the appropriate openings area in the building envelope to achieve a desired cross ventilation at certain times may cause dust accumulation or humidity problems in a dry desert or humid climate. A conflict may appear also for the same function at different time periods, for example, the appropriate wall materials to achieve a thermal comfort in summer is so different than in winter (Researcher using Ref. [1] [4] [5] [7] [17] [18]). The first issue, which is the conflict among the different building functions is discussed through that paper, the second one was previously discussed in a former one [19].

4. Potentials of Achieving the Environmental Functions without Confliction

From previous, it was impossible to achieve more than a function using the same building component without confliction through different time periods and conditions, but recently there are a number of solutions that the designers may use to minimize that confliction as much as possible. These solutions depend on the concept of adapting the building for each environmental function without affecting the achievement of other functions, the numerous and rapidly developed smart systems may be taken into consider for that. All multi-function building components should be able to change and control their properties to be proper to its different functions through the different time periods, or at least to achieve these functions for the maximum time possible before confliction, taking into consider the most important function to be achieved for each time period in the case of certain occurred conflict (Researcher using Ref. [4] [6] [17] [18]).

Continuity of some functions can be achieved when the building can mutate temporally with the changing nature, for example, buildings can adapt the change of air temperature during the hours of the day and night and among different seasons by changing the glass properties of the windows [8]. A number of new and developed materials appeared to help the building adaptation to achieve its environmental functions for the longest possible time periods. Nano and biotech materials, such as aerogel based plasters, thermochromic glazing and thermal energy adsorbing glass are some recent materials examples to achieve adaptive buildings. There is a future generation adaptive glazing such as the optically transparent, thermal energy adsorbing glass composite that emulates the chemical reaction cycle of leaves by endothermic principles as a metabolic cycle for thermal conductance heat targeting [17]. The silica aerogel glazing is another example that in comparison with the conventional single clear glazing retained a 4% longer thermally comfort period, while the energy consumption of HVAC system was reduced by 4% - 7%. In the visual comfort point of view, the glare effect and near-window bright zone could be reduced significantly while indoor illumination level still met the requirement [5].

Nature's biological systems are living multifunctional mechanical information systems of chemical composition. They have the ability to learn and adapt to changing climatic conditions by self-regulation of solar adsorption, to achieve thermal management. These self-programmable controls of adaptive material performance will progress the surfaces of a skyscraper, from being a mere material entity to a dynamic one. This response to real-time performance change by the hour, season and weather conditions are exothermic management of a glass material as an energy flow cycle [17]. Recent systems prototypes for an Electropolymeric Dynamic Daylighting System (EDDS), Embed Electro-Polymeric Display (EPD) technology, or "micro-muscles", into the interior

surfaces of insulated glazing units for dynamic buildings provide solar tracking capabilities with increased visual comfort, design variability and occupant control. EPD technology developed for solar tracking and environmental response of pixelated EPD daylighting systems. Combined into a multi-layered pixilated electroactive glazing system, the EDDS is capable of responding to fluctuating environmental conditions for daylighting and solar control, while providing individual control for visual comfort and information display. It can address variable solar heat gain control and visible transmittance while addressing diverse occupant preferences for visual effects and interaction [18].

5. Role for the Environmental Assessment Methods of Buildings to Encourage Minimizing the Functions Conflict

The environmental assessment methods of buildings emerged across the world to determine the environmental principles and standards for buildings. They are used in issuing assessment certificates to confirm the building commitment to the environment according to specific classifications. The "Building Research Establishment Environmental Assessment Method" (BREEAM) was the first, which released from the Building Research Establishment (BRE) in the United Kingdom in 1990, then many others appeared. The most well-known and widespread method is "Leadership in Energy and Environmental Design" (LEED), which appeared in 1998 from the US Green Building Council (USGBC) in the United States of America, and was applied in 2000. The Australian method, Green Star, and the Japanese method "Comprehensive Assessment System for Building Environmental Efficiency" (CASBEE) are some other examples of the assessment methods. Assessment methods create a system for comparing buildings to one another, establish a specific scale for classifying buildings in terms of environmental performance, and put designers into competition to achieve the best relations with the environment [20]-[23].

Currently, the environmental assessment methods of buildings are considered the most effective way to spread any environmental issue, they are widely used and encouraged by governments and confidential international institutes, and they are well-known around the world from different sectors [20]-[23]. Linking any issue by these assessment methods ensures its spread and attention attraction. Including an issue like minimizing the environmental functions conflict in buildings within the assessment methods can be done by one of two ways, either by considering that issue as a separated assessment item in one of its assessment fields that may accomplish points as a part of the overall assessment score, or by considering it as an additional practice that accomplish additional points to the overall assessment score. The presence of minimizing functions confliction in the assessment methods will raise the attention of their assisting technologies and application, and will prevent designers from focusing the achievement of some environmental functions while underestimating others when they are relayed on the same building component to be achieved.

6. Proposed Way to Assess Minimizing the Environmental Functions Conflict in Buildings

To assess the confliction degree among different functions in buildings within the environmental methods of buildings, a number of steps are proposed to be followed, as shown in the next sections.

6.1. Connecting the Achievement of Items by the Time Periods They Last Through

The assessment of functions confliction is related mainly to the time periods they last through. A previous proposal was introduced by the researcher to set the way of assessing the items score within the environmental assessment methods of buildings, which helps assessing the continuity of achieving each assessment item, and identifying the periods of time that different levels of achievement requirements can last through [19], the assessment items' score in that proposed way consist of two parts:

First: A score or more corresponding to an achievement level or more that can be achieved by the building for the item requirements through different time periods. These levels can be divided into several levels starting with not accomplished (which may be 0% of accomplishing the requirements) to a complete accomplished requirements level (which is 100%).

Second: A score or more corresponding to the time periods that the previous achievement levels are accomplished [19].

Therefore, more than one level may appear to achieve the items requirements, and each of these levels has its own degree of continuity depending on the different environmental variation types associated with each item [19]. The types of environmental variations that affect the continuity of achieving items are:

- Periodical variation, which occurs at frequent intervals such as daily variation of day and night, and annual variation of seasons.
- Sequential variation, which is a constantly change evolving with the passage of time, such as worn out, dust accumulation, resource depletion, human aging and urban changes.
- Sudden variation, which is an unexpected change to the environment such as earthquakes, volcanoes, floods, wars, or a radical change of a building function (Researcher using Ref. [2] [6] [10] [12] [18]).

When applying the previous way in determining the items evaluation, the time periods in which they are achieved will be integrated with their assessment steps, therefore, the confliction of functions associated by these assessment items can be determined easier.

6.2. Determining the Items of Conflicted Functions

Designers should determine the building components and their relation to each function when submitting the building to be assessed. This step will lead to determine the building components that are responsible for achieving more than an environmental function in the building. Building components used for the environmental functions may include: sensors, walls, ceilings, doors, windows, partitions, solar cells, etc. An electronic tool is proposed to make it easier for the submitting designers to enter their required data, this electronic tool has a saved default data for the expected buildings components of the different functions, so, designers are required to only change this default data when using different or unexpected components to achieve any of the functions. Thus, designers are mainly required to enter their buildings spaces' area and design to help the electronic tool concluding and displaying the expected components for the different functions for the designers to be modified if necessary. The buildings components are converted in the electronic tool into symbols related to their different building spaces, so, the building space prototype will have a symbol such as A_1, A_2, A_3, …, and each building component will have a symbol such as win_1, win_2, win_3, … for windows, lov_1, lov_2, lov_3, … for louvers. Besides, each environmental function in the electronic tool has a number, such as: Function 1, Function 2, Function 3, etc. Thus, the components responsible of the different functions are described and appear using the previous characters, such as: to achieve Function1, A_1win_1, A_1lov_1, A_2wall_2, … are used.

The assessors check this information and agree to them before their assessment, as the final building components will appear in a list for each assessing item. Noting that, the same function can be done using a number of building's components and the same component can do a number of functions. When assessors agree to the designers inputs; the way of displaying the previous relations are changed to be according to the building components not the building functions, which means that a list of the building components appear in a table in the form of: building space symbol and building component symbol then the functions done by it between brackets, for instance: A_1lov_1 (1, 3, 5), which means that $louver_1$ in the building space "A_1" is responsible of or contributes in achieving the functions: 1, 3, 5. From the previous, the expected conflicted functions are of the numbers appeared together beside each building component as long as they are affected by the same variation types, which is determined in the next step.

6.3. Equations Connect Items by Their Associated Variation Types

Most items are related to one or more variation type that influence their achievement and control their continuity characteristics over the time. As previously mentioned, these variation types are divided into periodical, sequential, and sudden. In an initial stage, experts may link each item to its variation type/types. To do that, symbols for different types of variations that may be associated with different assessment items are given, such as giving the symbol A for the daily periodical variation; symbol B for seasonally periodical variation, and so on for all other types of variation. **Table 1** shows some proposed symbols for some variation types [19].

Next, different types of variation are selected according to their connection and effect on different items requirements, which leads to determine the variation type that every item should take into account to achieve continuity. One or more variation types can be represented for each item, as in the following example represented in **Table 2** [19]. As the variation types' symbols associated with the items were taken from those proposed in **Table 1**.

Table 1. Proposed symbols for variation types which may affect the assessing items.

Periodical			Sequential					Sudden					
Daily	Seasonally	Worn out	Changing urban characteristics	Accumulation of dust	Accumulation of waste	Natural phenomena (as thermal greenhouse effect)	Emergence of emissions	Emergence of electromagnetic fields	Sudden removal of a nearby building	Earthquakes	Floods	Wars	Permanent change in use
A	B	C	D	E	F	G	H	I	J	K	L	M	N

Table 2. Example of connecting different types of variation to an assessing item.

Main assessing item	Secondary assessing items	Type of variation types associated with
Thermal comfort	Provide required ventilation rates	A-B
	Achieve appropriate temperatures	A-B-G-J-N
	Achieve appropriate moisture content	A-B-G-N
	Thermal insulation of used equipment	N

After that step, the items of conflicted functions can be determined exactly, as the electronic tool can filter the items that are related to functions that depend on the same building components and variation types. These items are the ones that of expected confliction, and those should go through the next steps. It should be recognized that, each assessment method has its different assessment items and requirements, thus, the items of expected confliction or overlapped relations between the building and the environment are different among these methods for the same building, so the proposed electronic tool is recommended not to be related to a certain method, but related to the environmental functions that are found at any assessment method. For example, in LEED, a number of items of the human needs functions are expected to be conflicting with each other if depended on the same building components to be achieved, and connected to the same one or more variation types, these items are: Thermal Comfort, Interior Lighting, Daylight, Quality Views, Acoustic Performance, Indoor Air Quality, and Low-Emitting Materials. While in BREEAM, they are: Visual comfort, Indoor air quality, Thermal comfort, Acoustic performance, and Safety and security (Researcher using Ref. [21] [22]).

6.4. Determine the Intersected Time Periods among the Conflicted Assessment Items

If the same building component is responsible of achieving more than an environmental function that are related to one or more similar variation type, then the assessors will assess their confliction of achievement over the different time periods using the proposed electronic tool. After the first step that is "Connecting the Achievement of Items by the Time Periods They Last Through", each item is prepared to be assessed according to its achievable time periods for each variation type associated with it, the levels of assessment could start from "always" (100% of verification) and ended by "rarely" (may be 0% of verification), and in between there are number of achievement levels. Each type of variation can be divided into levels of continuity and expressions corresponding, as the time achievement levels of daily periodical variation can be divided depending on the number of hours to achieve continuity, the seasonal periodical variation can be divided depending on the number of months, the sequential variation can be divided depending on the percentages expressing the degree of compatibility with the process that affects each item's requirements, and the sudden variation can be divided depending on the percentages reflecting the degree of compatibility with events affecting the item's requirements (Researcher using Ref. [19]).

If the assessor chose the achievement time level "always" for any variation type; it means that it is achieved all the time during it, so the next steps are not done and this function does not conflict with any other functions. But, if the assessor chose any achievement time level that is not "always" then a detailed time periods of achieving the item is required. Thus, another set of choices appears for each variation type that the item is associated with to determine the detailed time periods it lasts through. **Table 3** shows an example of a list of choices that may appear to the assessor to determine the detailed time periods of achieving an item, noting that these

Table 3. An example of a list of choices that assessors may use to determine a more detailed time periods of achieving an item.

Variation type	Achievement time periods (could be multi-choices)
Periodical daily variation	In the morning (from 6:00 to 10:00)
	In the noon (from 10:00 to 14:00)
	In the afternoon (from 14:00 to 18:00)
	In the evening (from 18:00 to 22:00)
	In the midnight (from 22:00 to 2:00)
	In the dawn (from 2:00 to 6:00)
Periodical seasonal variation	Summer (from June to August)
	Autumn (from September to November)
	Winter (from December to February)
	Spring (from March to May)
Sequential variations	Every hour
	Every day
	Every week
	Every month
	Every year
Sudden variations	Along with big events (earthquakes, floods,…)
	Along with medium events (sudden pollutants, peak periods,…)
	Along with small events (sudden light, noise, dust,…)

choices should be set by the experts of each assessment method, and they can be more than one choice among the variation types and within the same one.

According to the assessor choices of the detailed time periods for each item through the proposed electronic tool, all items that are related to environmental functions of the same building components to be done by; will have resulted intersection of the time periods they are achieved through for each variation type. The intersected time periods of achieving the environmental functions illustrate the periods that the designers succeed to minimize the conflict of the environmental functions using the same building components through. For example, if a window helped to achieve a thermal comfort during the morning only while it helped to achieve visual comfort during the other time periods, then the designer failed to have an intersected time periods between the two functions using the same window, and these two functions are completely conflicted.

6.5. Determining the Score for Minimizing the Confliction among a Building's Functions

An overall intersected time period is gathered from the different intersected time periods of the different variation types among the conflicted items to determine the corresponding score. **Table 4** shows proposed results of the overall intersected time periods among a conflicted items.

Thus, for the previous window example of the zero intersected time periods between achieving a thermal and visual comfort, the building gets zero in the score of minimizing the conflict of those two functions for the assessed space, and by knowing all the intersected time periods of all functions through the different building spaces; the final score of that issue can be gathered after multiplying each score by the building space volume ratio to get a unified score for the building considering the different building's spaces volumes. Therefore, the final building score of minimizing the environmental functions conflict of the building can be calculated as follows:

Score of Minimizing confliction = (*result ratio of the space prototype* A1 (*depending on a designed table like* **Table 4**) × A1 *volume ratio*) + (*result ratio of the space prototype* A2 (*depending on a designed table like* **Table 4**) × A2 *volume ratio*) + …*etc*.

Noting that, the

Table 4. A proposal for the related ratio results of the different overall intersected time periods among conflicted items.

Overall intersected time periods	Related expressions	Related ratio results
100%	Full intersection	10%
75% - 99%	Large intersection	8%
50% - 75%	Moderate intersection	6%
25% - 50%	Partial intersection	4%
1% - 25%	Small intersection	2%
0%	Zero intersection	0%

Volume ratio of any space prototype = number of that space prototype in a floor × number of typical floors that contain them similarly × volume ratio of the space to the whole building.

As previously mentioned, this score can be a main assessment point, thus considered in the total assessment score of the building and have its own weight, or it may be an added assessment point to the overall assessment score, similarly to the innovation score points. If the score of minimizing the functions confliction is an added value, the score can be calculated as previously determined but with the inclusion of the items assessment scores weigh that they are related to, to include the importance degree of the benefited items, which means that,

Score of minimizing confliction = (*result ratio of A*1 × *A*1 *volume ratio* × 10% *of the related items assessment weights* + (*result ratio of A*1 × *A*2 *volume ratio* × 10% *related items assessment weights)* + *…etc.*

Noting that, the related items are those containing the affected functions that may be conflicted with each other. And, considering the related item's weights in the previous calculation will lead to risen the importance of minimizing the functions confliction of the higher weighted items more than the less weighted items, noting that these weights are reflecting the more important items according to the experts, which vary over the time, place and building function.

7. Benefits of Assessing Minimizing the Environmental Functions Conflict in Buildings

The main disadvantage of the proposed way in the research is the expected consumed time and effort to enter the required data and use them in the assessment, so, it is preferred to depend on an electronic tool to help designers entering their data using default settings to be modified, help experts to go through the methods items to decide the supposed confliction occurrence, and help assessors to choose easily from a list of processed choices. On the other hand, there are a number of benefits that may be achieved when minimizing the environmental functions conflict in buildings. Some of them could be displayed as follows:

- Encourage designers to deal with the recent building technologies that may help achieving a greener building by accomplishing a more sustainable relation with the environment, even if these relations are inconsistent with each other, especially when using the same building components to be achieved, such as dealing with technologies that dynamically respond to internal and external stimuli.
- Encourage designers to achieve all conflicted functions within an acceptable range and achievable time.
- Prevent designers from focusing on achieving some environmental functions and ignore others as a result of their confliction over the different time periods, especially when using the same building component to achieve these functions.
- Help achieving the different human balances (physical, chemical, psychological, and radiological) continuously over the time within the same spaces.
- Help an individual control for the different comfort types when taking into account some dynamic technology, which lead to greater satisfaction with the indoor environmental quality and overall occupant well-being.
- Help comparing buildings in terms of their capability of being interactive with nature and human needs.
- Express buildings fairly in return of their capability of dealing with different variations affecting them, and affecting the achievement of different environmental functions associated with them.

For the environmental assessment methods of buildings, the main gained benefit is achieving a more accurate assessment results of buildings when including the building capability of maintaining the assessed environmental functions the longest possible time periods, rather than only covering the determined given times and conditions within the current assessment methods of buildings to get the items scores.

8. Conclusion, Results and Recommendations

The environmental assessment methods of buildings were set to ensure that buildings met environmental standards. A problem associated by occurred confliction among the different environmental functions of the buildings appears, while the current assessment methods do not reflect the awarded points of buildings that can achieve the different environmental functions with the less achievement confliction over the time. There are great recent potentials to determine and minimize the supposed occurred conflict among the different functions, such as the use of smart dynamic technologies, and developed interactive materials. Including the building capability of maintaining the required environmental functions over the time helps more accurate results towards sustainability, and helps the attention attraction to their possibilities around the world to be applied and encouraged innovatively.

The research paper aims to set a proposed concept to assess the building ability of minimizing the building environmental functions confliction, especially the use of the same building components through the different time periods. The proposal emphasized the importance of determining the multifunctional components to be improved through the different time periods to reach the least conflict for their functions. The proposal depends on using an electronic tool to determine the building environmental functions that are affected by the same variation types and use the same building components to be achieved, then assessors may determine the time periods that these functions are achieved within to conclude the intersected time periods among them, these intersections indicate the conflict minimizing percentage of these functions, and can be awarded to be main or additional points to the overall assessment score.

Designers are recommended to find innovational concepts to connect their buildings with the varying affecting conditions to reach a building with the least confliction among its environmental functions over the time. Green Building Councils and assessment methods institutions around the world are recommended to develop the concept of minimizing the environmental functions confliction of buildings within their methods, to help spreading that issue around the world, spreading the technologies related to them, and getting more accurate and credible results when expressing the buildings sustainability through their final scores. They are recommended then to develop their own assessment way to ensure their environmental functions' continuity over the time.

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