

# Development an Adaptive Environmental Assessment Method for Buildings

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## Abstract

The idea behind this work is developing an adaptive method for the environmental assessment of buildings, to configure different versions according to the variables affecting them (spatial, temporal and associated with building characteristics) to suit different evaluated projects. This method may be applied using an electronic tool, which is in a development stage. Amending different assessment versions of the adaptive method is done by including the variables effect, according to set of steps, such as modifying the formulation of the assessment items, adjusting their estimation weights, and amending their achievement evaluation levels and their returned scores. When using the adaptive method, the assessment result of a building using a certain version differs from the results using other versions, even in the same country, so configuring an appropriate version due to the variables affecting the assessment helps getting more accurate results than the ones currently provided. The main goal of that research is to introduce the adaptive method that is proposed to ensure a fairer assessment results from the perspective of Green Architecture, and allow a more credible and accuracy of results comparison according to the environmental performance of buildings. The researcher analyzed the different main features she used in developing the adaptive method, the Comparative aspects between it and the current assessment methods, and the expected reached advantages from its usage. The paper arrived to the importance of adapting the environmental assessment of buildings according to the different affecting variables, and recommended developing the adaptive method and its tool to the stage of application to benefit its advantages.

## Keywords

Environmental Assessment Methods of Buildings, Spatial Variables, Temporal Variables, Natural Periodical, Sequential, and Sudden Variables, Adaptability

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## 1. Introduction

Due to the great diversity in the internal countries' characteristics, there is a need to include the effect of their spatial variables on the environmental assessment of buildings results, to get them in the utmost fairness and accuracy, and a need for an appropriate assessment criteria for producing a more compatible version with their affecting variables associated with time, place and building characteristics to achieve the highest credible assessment. Many researchers studied the differences between the different methods around the world, these differences were expected due to the different spatial characteristics of their producing countries, besides the different time periods and building types. Inbuilt [1], Todd *et al.* [2], Schwartz *et al.* [3], Fauzi *et al.* [4], Reed *et al.* [5], Tsukamoto [6], Dirlich [7], Saunders [8] and Roderick *et al.* [9] spot a light on the deep differences between the different methods. Thus, using any of these methods out of its designed spatial and temporal borders will lead to inaccurate assessment results. Dirlich [7] presented a basic concept for an assessment scheme that could be used on a global scale as a standardized system. This concept was due to his point of view about the insensibility of the assessment methods diversification that took into account local characteristics in the various countries versus the globalizing market for real estates.

Number of international versions had been emerged to help the modification of an existing method to suit different countries characteristics. Aubree [10], the Building Research Establishment [11] [12], and the Indian Green Building Council [13] introduced a number of the produced international versions that helped a closer vision and more appropriate results for the places they are produced to. Some other researchers introduced the Sustainable Building Tool (SBTool), which is a generic framework designed to allow countries to develop their own local rating systems, it may be used by third parties to do so. The SBTool is based on the philosophy that a rating system must be adapted to local conditions before its results can become meaningful. Larsson [14], Guilherme Castanheira *et al.* [15], and Kuo *et al.* [16] discussed the SBTool, its adaptation advantages, and its application in some places.

This paper seeks to put a set of principles and bases by which an adaptive environmental assessment method for buildings can be designed and developed later on by any competent or interested institution, besides encouraging the development of an initial electronic tool that can apply this method. The paper relays mainly on a comparative study to show the benefits resulting from its proposed features, these features were proposed to help the guarantee of an even assessment by using different versions that suits the different projects, help to find an equitable evaluating approach for all buildings in spite of spatial, temporal and building characteristics variations. They also help to get a unified perspective according to the Green Architecture principles, not according to the best practice can be obtained in the producing countries, ensure justice in comparing assessment results of buildings with each other to determine the most efficient in dealing with the environment, help to set a fair classification for buildings around the world, help creating a fair competition to reach the outmost sustainability between different regions.

## 2. Environmental Assessment of Buildings

Environmental assessment methods of buildings appeared to lay the principles that are meant to be reached with the environment, posed by the Green Architecture principles. Assessment certificates were issued and granted for buildings to confirm their commitment to the environment according to a specific classification. The environmental assessment concept appeared in line with the increasing environmental awareness and the need for global systems to measure its application in various sectors. In the building sector, significant and accelerated development appeared in the field of issuing certificates to assess the environmental dimension within, according to number of assessment methods around the world [4]. To use the environmental assessment methods of buildings effectively, they should help creating a comparison system between buildings, and making a specific scale for the classification of buildings in terms of preference in dealing with the environment [3].

A number of environmental assessment methods of buildings appeared all over the world. Building Research Establishment Environmental Assessment Method (BREEAM) in England is considered the first [1], which emerged in 1990. Many different other methods appeared later in other places in the world, such as Leadership in Energy and Environment Design (LEED) in the United States, which first appeared in 1998 and began to be applied in 2000, Green Star in Australia, which appeared in 2003, and Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in Japan in 2004 [7] [8]. These methods were developed for assessing green buildings regarding many issues such as energy, water and indoor quality.

Green Building Challenge (GBC) appeared in Canada to deal with variables affecting the environmental building assessment. It was under construction since 1996 through a variety of specialists and was handed to the International Initiative for a Sustainable Built Environment (iiSBE) in 2002. GBC was created to help countries producing their own assessment tools. The Green Building Tool (GBTool) was introduced as an assessment tool for GBC which was upgraded later to Sustainable Building Tool (SBTool). The idea of this method depends on developing general values that can be replaced with local values by local experts to determine the levels of appropriate performance [14]-[17].

### 3. Critique the Flexibility of Current Assessment Methods

Current environmental assessment methods of buildings show a lack of correlation variables affecting the evaluation, thus an imbalance results in accuracy and unfairness in buildings comparison between different places and time periods. That may reduce the possibility of global spread for buildings environmental assessment without the appearance of shortcomings in spite of the urgent global need for such a deployment. Differences between current building assessment methods leads to different final results for the same building in the same place and time, these differences include different assessing weights used for the same items, a different formulation for these items, different evaluation approaches used, different ways to determine items scores and final score, different concerns for the assessed issues, and different final classifications. Problems linked with these differences show up when the assessing method fails in expressing the environmental efficiency of buildings beyond the spatial and temporal borders which designed for. Therefore, it is difficult to compare building results of various assessments, and difficult to determine whether a building which may succeed using a method can succeed using another one (Researcher using Refs. [1]-[9]).

Despite the emergence of solutions to treat problems connected to the spatial transmission of the assessment methods, many of spatial and non-spatial variables and effects were not taken into account, which led to continuing many shortcomings that reduces confidence in their justice. The main current solution of treating spatial variations in the assessing methods is the emergence of international versions of the most widespread methods such as the Leadership in Energy and Environment Design (LEED) and the Building Research Establishment Environmental Assessment Method (BREEAM). Another main solution is the emergence of the Sustainable Building (SB) tool, which is an electronic tool for the Green Building Challenge (GBC) assessment method. This tool was designed to help different countries publish their own rating systems (Researcher using Refs. [10]-[21]).

Besides the foregoing, buildings are currently assessed around the world using some famous methods without any modifications, such as LEED, and some countries are creating or developing their local assessing method to be used nationally (Researcher using Refs. [22]-[24]). For each previous way to assess buildings, some defects that are associated with them can be summarized as follows:

- Using any assessment method directly without modifications: Insufficient in including or expressing spatial variations beyond the borders it was designed for, besides ignoring the advantages of other methods, which might include more appropriate items (Researcher using Refs. [8] [25]-[30]).
- Configuring a local method to be appropriate to each country's characteristics: Need a huge time and effort, with a wide possibility of effort duplication among countries. Besides, the difficulty of their confrontation competition to other known and widespread methods (Researcher using Refs. [21] [31]-[33]).
- Using international versions of LEED or BREEAM: consumes a lot of time and effort because of their association with more than one aspect. Standards used in them are not to be changed unless the substituted standards are equally strict or stricter than the existing standards, which can't be achieved in many local codes. They are also affected by the view and culture of the original producing country and their markets' requirements, which can be noted clearly in the significant differences of the assessed issues and weights between BREEAM Gulf and LEED Emirates, which are designed for the same region. The international versions depend mainly on deleting the specialized items and keeping general ones, which leads to empty the method from experiences that were included in it, causing a work duplication, waste of time and effort, and experiences conflict when putting items that were existed previously (Researcher using Refs. [10]-[13] [21] [33]).
- Using the SBTool: Doesn't allow distinguishing the effect of some variables from others for the various items, as the variables' impacts are gathered by four similar characteristics for all items. Besides, there is no total environmental performance result for assessing buildings that can be compared with other buildings'

results, as the assessment process is divided into different stages without having an appropriate mechanism for combining different assessment results of these stages into one, especially with the possibility of deleting some of the main assessing issues in some of those stages for different countries. The maximum and minimum evaluation levels scores are fixed in spite of the ability of changing the items requirements, which its maximum target is not restricted to 100% of achievement, and its minimum evaluation level has a negative signed score, even if the parallel requirements are not harmful (Researcher using Refs. [17]-[20]).

#### 4. An Adaptive Environmental Assessment Method of Buildings

The researcher proposed an adaptive method which allows to deal with different variables affecting the environmental assessment of buildings, to make it easier to produce versions that could spread across time, place and different building characteristics. It had taken into account the benefits of previous methods pursued this path and tried to avoid their disadvantages as much as possible, besides, adding new features that may improve the accuracy and reality of the assessed results. It is suggested that a unified institution that includes experts from various countries of the world-according to a specified level of experience-may work on modifying the different versions of the adaptive method according to variables influence on them. These variables are the related spatial, temporal, and building characteristics variables. Modifications are done by amending the assessment items requirements, adjusting the assessment weights of items and fields to reflect their relative importance of achievement, determining the presence and mandatory degree of different items, modifying the levels of assessment requirements and their returned scores, modifying and determining the relationships leading to get the evaluation results, linking the evaluation results with the building capability of meeting the affected variables on achieving the assessment items requirements and their continuity over the time, and determining score relations between the main and additional items.

The adaptive method was designed as much as possible to allow future modifications without the need for radical changes. It consists of three main fields which are branched to main items, then secondary items then sub-items. The method is also divided into 10 environmental functions through the main three fields. It used the most famous environmental assessment methods to get and form items that can be found in any place, time, and building types. Therefore, the method is amended by deleting any of these items or modifying them rather than adding new ones. The fourth field is a field that contains any additional and preferential items that may be not associated with achieving the Green Architecture principles, but useful. Any new items that appear and don't exist in the other three main fields may be included in that field.

#### 5. A Proposed Tool for the Adaptive Method

The researcher had designed an initial tool using the Excel Program to introduce the Adaptive Environmental Assessment Methods of Buildings. This tool still needs a lot of modifications to be developed and used practically. It consists of a number of sheets that can be divided according to their users. There are a number of sheets that the designers should enter their project's details through, a number of sheets that the chosen experts to amend the method should apply their modifications to produce the assessing versions for the assessed projects, and a number of sheets that the assessors use to assess the projects according to the amended method's versions.

The project designers should enter some data to help the amending experts to know the variables affecting the environmental performance of their building(s), they are asked to enter the related time periods of the project (design, construction, and occupancy), the project's place and its spatial characteristics, and the building(s)' characteristics such as their type, age, volume and spaces noting that the spatial characteristics may be entered using electric sites that are internationally reliable, trusted and well-known. Experts may use the designers' data automatically in the next sheets if approved by them.

Experts responsible of amending the adaptive method into its versions are divided into three groups, the first group is responsible for determining the used data to amend the method's versions, the second group is responsible of amending the assessment fields and items formulation, the third group is responsible of amending the assessment fields and items existence and weights, and the fourth group is responsible of amending the assessment achievement and continuity levels for the different assessment items. Experts responsible for determining the used data in the different versions may refer to electronic trusted sites, the designers' data after their approval, and sometimes their experience, especially for the human-related variables effect such as the culture and tra-

ditions. The resulted data from that stage is divided into temporal, spatial, and building characteristics variables that affect the assessment formulation, weights, and achievement levels. Each of these variables is connected automatically in the next sheets by the assessment components that are affected by them, thus, all other experts amending the adaptive method's versions depend on the resulted variable's data from that stage.

Experts responsible of amending the items' formulation start to study the automatically linked variables effect on the formulation of the previously determined specific parts of each item, to change them according to their affecting variables. These parts are the specific requirements to achieve the items. They are either standard, laws or codes to be followed, or certain characteristics, numbers, or percentages to be verified. Experts responsible of amending the assessment items' weights start according to the affecting variables and each amended item's formulation to decide its existence, its obligatory level, and its weight. Noting that any changed weight of any item will change the other items weights of the same component by their relative proportions to each other, to remain the assessment overall weight 100%, and any changed weight of any component will change its consisted assessment components' weights by their relative proportions to each other. And it should be noted that, after each weight emendation there should be a step to ensure remaining them within an accepted limit, these limits are proposed to be in the adaptive method a minimum assessment main functions' weights, besides a minimum proportion between the assessment items' weights expressing the environmental quality achievement (Q) versus the assessment items' weights expressing the environmental load reduction (LR).

Experts responsible of amending the items' achievement levels start amending each item according to its automatic linked variables to decide their effect on the achievement levels' number of the item, their divisions and ranges, and their corresponding scores. For these items another set of levels are set, which are expressing their achievement continuity depending on their verification temporal characteristics and the affecting variations types. These experts are responsible also for determining the additional items' achievement levels which may be a proportion from an existing assessment item. After amending the method's versions they may be saved through a system that helps categorization them according to the different spatial levels. As the countries spatial level contains the versions of their climatic regions which include the versions of their internal governorates, cities and villages, each spatial level contains a detailed one until the specific projects' spatial levels.

Assessors decide the proper version to assess any project, then start to assess each item by choosing its achievement level(s) and their parallel continuity level(s) for all time periods. The electronic tool helps the assessor to get the assessment results, which reflect the efficiency of buildings environmentally through a series of choices. They are using the modified items requirements formation to decide their verification, then the sum of the corresponding scores of the achievement levels through their continuity levels are multiplied by the previously amended assessment weights, then the assessment achievement points are gathered to decide the final assessment score for the building(s) and its classification.

## **6. The Proposed Characteristics for the Adaptive Method**

The researcher had proposed number of characteristics when designing the adaptive method to help responding to variations, assessing the continuity of achieving the items requirements, obtaining a fairer results and comparison between buildings environmentally. In general the adaptive method was designed to have a set of characteristics that helps it to get several advantages. The most important of these characteristics are shown in the following.

### **6.1. Proposed Characteristics for the Method's Assessment Fields**

It is proposed that the adaptive method contains four assessment fields, three of them are main and the fourth is an additional one that includes any additional or preferred items. Each assessment field consists of main items that are divided into secondary ones, and each secondary item contains one or more assessing requirement. In the following, some suggested characteristics of the assessment fields in the proposed adaptive method are displayed.

#### **6.1.1. Reflecting the Environmental Equilibrium Relationships**

There are three main environmental equilibrium relationships associated with buildings that include all the green architecture principals within connected cycles. These relationships were proposed to express the main assessment fields, which are the site's natural environment, the life cycle of the building, and the occupiers' require-

ments<sup>1</sup>. These three continuous and connected relations can cover any item related to Green Architecture even if new or unusual. A comparison between the proposed method and the current assessment methods for their fields' expression and comprehensiveness can be show in **Table 1**. The advantages resulted from this feature can be discussed, as follows:

- Dealing with the three main circled goals of Green Architecture, these goals are integrated with each other and each of them are integrated with the final goal, and there is no doubt of their comprehensiveness, which helps including any Green Architecture principle, even if new.

**Table 1.** Comparison of some the assessment fields' characteristics between the adaptive method and the current assessment methods (researcher using Refs. [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Comparative aspects	Adaptive method	Other assessment methods
<b>The main assessment fields</b>		
Expression	Express the three Main environmental equilibrium relationships associated with the buildings performance.	Different environmental issues with no connection among them, except for CASBEE and the methods based on it (which connect its fields' expression according to the BEE indicator). <sup>a</sup>
Comprehensiveness	The three environmental equilibrium relationships Include all environmental functions that are or may be associated by the Green Architecture, without overlooking any of them.	Some of the Green Architecture principles may be overlooked in order to focus on specific environmental issues that represent for some countries the most important ones.
Unification	Unified for different places and building characteristics.  Unified over the time.	Varies between the different assessment methods depending on the priorities related to the producing countries and the specialist's view of each. <sup>b</sup>  Can be changed for the same method over the time by adding, removing, merging, and separating them depending on different newcomers of their importance, leading to difficulty of a fair comparison between the results every time. <sup>c</sup>
<b>The additional assessment field</b>		
Existence	Complementary field to include any additional and innovative items.	Appeared in most of methods to assess innovations in particular, and didn't appear in some others, such as GBC.
Assessing scores	The additional Items' scores vary according to the expert's determination depending on place, time and building characteristics.	The parallel assessment scores for its included items are fixed.
Limitations	There is no maximum limit for the final score of the additional field to encourage innovation, and there is no maximum number of the new assessed features, elements or relationships	There is a maximum limit for the final score, and a maximum number for the accepted innovations.
Relation with the main assessment fields	The additional items' weights are set using mathematical relationships with the associated items included in the main fields, to reflect the relative importance of their existence and application depending on their related item's importance.	There is no relation between the additional innovation field and the other assessment fields.

<sup>a</sup>Building Environmental Efficiency (BEE) is used to form the framework for CASBEE (Researcher using Refs. [6] [8] [31]). <sup>b</sup>Assessment fields differs between different methods, as they depend on the importance degree of the assessing issues according to specialists view. They also defer in their number, For example, in the same period of time LEED consisted of eight assessing fields while BREEAM had 10, each of them were divided in different ways, even with the presence of some similar fields (Researcher using Refs. [1] [3] [8] [25] [29] [36]). <sup>c</sup>In LEED, for example, the field "Sustainable Sites" "in the 2009 version was separated to two fields in 2011 which were "Location and Linkage" and "Sustainable Sites". On the other hand, the field "Regional Priority" was integrated within the field "Innovation and Design process", while a new field appeared which was "Awareness and Education". Such radical differences in the method structure and main components lead to impossibility of comparing the assessing results for the same method over the time fairly (researcher using Refs. [27] [36] [37]).

<sup>1</sup>These fields are the site's natural environment (which is balanced normally and should be obtained as it was before the building existence or better), the life cycle of the building (which is required to be closed through building stages of construction, operation and demolition, taking into concern entering materials and different resources in the building cycle or other natural cycles), and finally the occupiers' requirements (avoiding the negative impact and achieving positive effect from buildings on human equilibrium relationships) (researcher using Refs. [2] [8] [38] [39]).

- Avoiding putting unequaled assessing issues versus each other, such as putting the achievement of the sustainable site and nature at the same assessment level of achieving the water efficiency, energy efficiency, or materials use efficiency, while all of the previous three issues are expressing one main issue which is the resources efficiency within the building lifecycle relationship. So, achieving a sustainable site relationship is parallel to achieving sustainable building life cycle, but with differences in the estimated weights of each to present their relative importance to each other, with a minimum limit for both weights—as will be displayed in the characteristics of success requirements.
- Avoiding transforming the environmental issues raised in the priorities of global attention into assessment fields, while reducing the attention or neglecting other issues that can be related to the Green Architecture principles as well, such as some issues related to the human needs<sup>2</sup>. Therefore, expressing the environmental relationships within the assessment fields ensures having all principles in attention without condoning some of them, even with the different estimation weights for each.

### 6.1.2. Unifying the Assessment Fields among the Method's Versions

It was proposed to unify the assessment fields over the time, place, and building characteristics among the different method's versions, to avoid the disadvantages previously resulted from their variation in the other current methods on their obtained results. Their internal items can be deleted and changes without changing their names and objectives, Thus, The evaluation is within a specific framework with a specific goal. A comparison between the proposed method and the current assessment methods regarding the previous assessment fields' characteristic can be shown in **Table 1**. This characteristic helps to achieve the following advantages:

- Avoiding deleting some fields or adding others over the time. Most other methods deal with the assessment fields according to their global concern, which may lead to put an issue as a separated field sometimes then merge it with other issues other times (Researcher using Refs. [8] [23] [30] [34]-[37]). Noting that changing the assessment fields over the time causes impossibility of comparing buildings results for the same method over the time.
- Avoiding the assessment fields' non-uniform structure across the world<sup>3</sup>, as the different assessment fields of the different methods reduce the possibility of comparing the results between the different methods, due to the dissimilar structure of them.
- Helping the assessment clarity, as the variation of the main assessment fields between the assessments methods of buildings means that there is a lack of the evaluation main goals clarity.

### 6.1.3. Possibility of Adding New Items within an Additional Assessment Field

As previously mentioned, a fourth additional assessment field may be added to the three main assessment fields to help adding any additional or preferred items, such as innovative ones, noting that the additional items may be changed into main items over the time. A comparison between the proposed method and the current assessment methods regarding the additional assessment fields' characteristics can be shown in **Table 1**. The additional field helps achieving number of advantages, as follows:

- Helping to embed temporal and technological variables in the assessment when needed, after including their effect on other items in the main fields.
- Keeping the assessment with open ends that are capable to extend to number of secondary assessment objectives, such as adding an item for the distinctive regional characteristics, an item for the environmental awareness and so on.

## 6.2. Proposed Characteristics for the Method's Assessment Items

The Assessment fields in the adaptive method are divided into several items in different levels. Those items are proposed to have flexible characteristics that may help adapting them with the different variables affecting the

<sup>2</sup>Such as reducing or neglecting the psychological human comfort achievement and harmful radiation prevention, as they do not represent urgent attentions, but are included in the Green Architecture principles. (Researcher using Ref. [8] [23] [25] [27] [30]-[32] [38] [39]).

<sup>3</sup>In LEED, for example, the assessment fields reflect different environmental issues over the time, and there is no environmental relationship to specify the reason for choosing those issues and not others, except being the most concerned in the United States at the time of designing any of the LEED's versions. The main assessing fields in LEED 2009 for example were: Location and linkages-Sustainable sites-Water efficiency-Energy and Atmosphere-Materials and resources-Indoor environmental quality-Awareness and education, while in 2009 they were: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and resources, Indoor environmental quality, and Regional priority (researcher using Refs. [30] [36] [37]).

assessment at any time, place, and for different building characteristics. In the following, some suggested characteristics of the assessment items in the proposed adaptive method are displayed.

### 6.2.1. Ability of Changing the Assessment Items' Formulation

This characteristic depends on changing certain parts of the assessment items to express the items' requirements, taking into consider that the changed parts in the items' formulation introduce the "preferred performance level" of the items unless they are 100% of the items' verification, which can be given a high score but not the final score. The final score of any item is only given for the 100% achievement level. A comparison between the proposed method and the current assessment methods regarding some item's formulation characteristics can be shown in **Table 2**. The ability of changing the items' formulation helps achieving a number of advantages, as follows:

- Helping the flexibility to modify items formulation by replacing specific determined parts in the items context when needed. Those parts represent the item requirements, whether in the form of numbers, percentages, required characteristics, or the form of standards, laws or codes required to achieve assessment scores.
- Helping the possibility of having more than one alternative standard, law or code that can be bounded to the same item, noting that, the related score of achieving any of them can be changed according to their rigor degree. This possibility is important especially for projects of special circumstances like multi-function buildings or multi-national buildings.
- Helping the possibility of using supportive standards, laws and codes beside the binding ones, not only versus each other.
- Determining the best practice of the items' requirements continually, which help designers to know their buildings' practice status in relative of buildings exposed to the same conditions.
- Helping the possibility of developing multiple alternatives to assess each item, allowing compatibility with all conditions that may be faced by the designer and the solutions that may be resorted, instead of having a specific formula either be achieved as it is to get a score or not, as in the current assessment methods. That feature is taking into account changing the scores corresponding to those alternatives according to their degree of rigor.

**Table 2.** Comparison of some assessment item's characteristics between the adaptive method and the current assessment methods (researcher using Refs. [1] [3] [8] [11] [12] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Comparative aspects	Adaptive method	Other assessment methods
<b>Items formulation</b>		
Type of emendation	Possibility of changing certain parts in the assessment items formulation for the different versions according to their different circumstances, besides linking those parts by variations affecting them.	Ability of changing the overall formulation of the items when issuing new versions, without determining certain changeable parts in those items.
Multiplicity of available alternatives	Possibility of putting more than an alternative to assess items requirements that buildings may succeed when achieve any of them, taking into account linking their rigor level with their corresponding obtained scores.	The items requirements are pre-defined and there is no ability to evaluate alternatives to achieve them. Local codes may be added as alternative assessment for some items in the international versions, but only when they are equal to the rigor level of the assigned ones, which is impossible for almost all of them.
<b>Items assembling</b>		
Coverage	Covering all items that can be exposed to for any place, building and different circumstances, to help just deleting from them rather than adding new ones. GBC method follows the same idea with the dissimilarly in the collected items number between the two methods.	Contain specialized items in the local methods, which can't be proper for the different places. While the international versions contain only general limited items that should be at any place.
Contained experience	All experiences are gathered from different methods with an ability to add more within the additional field. While, the GBC method doesn't have the possibility of adding new items, even of innovative.	International versions are emptied from a lot of experiences, effort and time spent in the formation of their originals, so repetition in effort may appear when configuring them to local versions, with the ability of experiences conflict between original and local experts.



- Helping the variety of design solutions to comply with any of the multiple assessment alternatives for the various items’ requirements. Thus, achieving diversity of efficient buildings formations.
- Helping configuring new versions by modifying certain sections within the method’s items rather than starting from scratch.

### 6.2.2. Covering All Items That May Be Exposed to

In the adaptive method, modifying the different versions depends on deleting items rather than adding new ones, this process is the opposite of that used in the international versions of LEED and BREEM as previously mentioned. Putting into consider the ability of adding items that did not appear in previous methods within the additional fourth field of the adaptive method. A comparison between the proposed method and the current assessment methods regarding the assessing items comprehensiveness can be as shown in **Table 2**. In the following, some advantages resulting from covering all items that the assessment may be exposed to:

- Reusing the consumed experience in the different methods.
- Saving time and effort, by avoiding repeating the same items from scratch for different assessment places.
- Preventing the contradiction between different experts’ experiences responsible of modifying different versions of the method, as may appear in the international versions which cause experiences conflict between original and local experts.

### 6.3. Proposed Characteristics for Items’ Estimation Weights

Every assessment field and item get its own estimated weight depending on its verification importance and its effect on the environment for the different places, time periods, and building characteristics. In the following, some suggested characteristics of the assessment items estimated weights in the proposed adaptive method are displayed.

#### 6.3.1. Converting All Items Estimation Weights into Percentages

As previously mentioned, some assessment methods relied on determining its versions final assessment score by gathering the maximum points given for each assessment item such as LEED, this process leads to lose the connection between the different final results of the assessed buildings and prevents the ease of comparing them among the different versions. The Adaptive method used the other way of expressing the estimated weights by converting them into percentages. A comparison between the proposed method and the current assessment methods regarding some assessment items estimated weight characteristics can be shown in **Table 3**. This way of expressing the items estimated weight helps to achieve the following advantages:

**Table 3.** Comparison of some assessment items estimation weights characteristics between the adaptive method and the current assessment methods (researcher using Refs. [1] [3] [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Comparative aspects	Adaptive method	Other assessment methods
<b>Items estimation weights’ value</b>		
Appearance	The estimation weights of the assessment fields and items are permanently converted into percentages to unify the final building score to be 100% for all method’s versions.	Some methods such as LEED use numbers to express the estimation weights of fields and items, which leads to different final assessment scores of buildings depending on the collected numbers which differ according to time, place and different building characteristics.
<b>Items estimation weights’ flexibility</b>		
Linking items’ relative importance to variables effect	Certain operations were set to include variables effect on the relative importance of the assessment fields and items, these operations include each variable’s “effect degree” with its “effect sign” and the variables’ “significance value” to each other when there is more than one variable affecting the same item.	No specific mathematical operations to include variables effect on items estimation weights. In GBC method there is an emendation operation that depends on four characteristics to determine the items’ estimation weights, but these characteristics are similar for all items and don’t cover all possible effects.
Possibility of emendation	Can be modified for each version for use or trail.	Cannot be modified for each version with the exception of the GBC method by using its SBTtool.

- Unifying the total final obtained score of buildings in spite of the different variables affecting the assessment.
- The possibility of comparing the buildings among all the different versions.
- Integrating the assessment fields and items weights continually and automatically, not only collecting them to obtain the final score. Therefore, any change or modification in the fields and items estimation weights leads to amend other weights to reach the total 100%, and it is possible to delete or add assessment items without affecting to the final estimation weight of the building.

### 6.3.2. Possibility of Determining the Items Estimation Weights According to Variables' Effect

The relative importance of the assessment fields and items are reflected by their estimation weights, which are changed according to number of variables' effect. This process is transparently done through the adaptive method's proposed tool, as the variables affecting each item are determined, then mathematical operations are used to reflect their effect on estimating the items weights. A comparison between the proposed method and the current assessment methods regarding the automated flexibility of estimating the assessment items weights can be shown in **Table 3**, and the advantages resulting from that characteristic can be discussed, as follows:

- Helping to know the reasons of how and why changing the estimated weights of the assessment fields and items in a transparent way, to reflect their relative importance according to the variables associated with time, place and building characteristics, rather than get the final assessment weights without knowing their process.
- Adjusting roughly the relative importance of the assessment fields and items easily for each new version without a need to wait the new releases.
- Helping the possibility of studying the effect of each variable individually on estimating the assessment weights of the assessment fields and items, and possibility to distinguish the relative importance of these variables versus each other for the same item.

### 6.3.3. Possibility of Reusing Estimation Weights Previously Determined

Reusing estimation weights helps including the same variables effect among the different related items. The reusing among the related items do not lead to the same assessment weight of these items, as they may be modified according to other different affecting variables beside the common ones, or they may defer according to the different "significance value" of the affecting variables of each item even if they are similar. There are two ways of determining the assessment items' estimation weights in the adaptive method, a comparison between these proposed ways can be shown in **Table 4**, showing their relation to the proposed reusing of the items estimation weights. The advantages resulting from that can be shown, as follows:

- Saving time and effort and avoid duplication of work when determining the effect of some variables to estimate weights of some assessment items, taking into consider the possible differences between the final estimated weights of these items, due to the possibility of considering other different variables affecting each of them, or considering different variables' "significance value" for each item.
- Helping to determine the estimation weights of some items included in the additional field by using relationships to reuse the estimated weights of other items (such as a specific percentage from the benefited assessment items included in the main assessment fields). These relationships are among items previously determined in the main three fields and items in the additional field, thus, include the variables' effect of the related items in the same manner without duplicating the time and effort of including them.

**Table 4.** Comparison of the different proposed ways to determine the items' estimation weights in the adaptive method [researcher].

Comparative aspects	Ways of determining the assessment items' estimation weights in the adaptive method	
	Direct	Indirect
How to determine	Use different variables effect for each item to raise or lower its estimated weight.	Set a relationship (Percentage) between the related items to determine unknown weights with the help of previously determined ones (reusing).
Benefits of using	Include the effect of different variables for each item.	Save time and effort by avoid work repetition to include variables effect among the related items.

- Avoiding unifying the estimation weights for all additional items as happens in the other methods, so when there is an innovative feature in the assessed building that would raise the efficiency of other items (in the main assessment field) that are not important (deleted or given a low estimation weight according to the affecting variables), thus the score given for the additional item should be low too, depending on the determined relationships with the items it is related to<sup>4</sup>, that are not fixed all the time (Researcher using Refs. [8] [18] [27] [28] [30] [32] [35]).

#### 6.4. Proposed Characteristics of Assessment Items' Achievement Levels

The items in the adaptive method are not assessed by a certain limit to be achieved or not, as in most other methods, they are assessed by more than an assessing level, these levels have varying characteristics according to the variables affecting the assessment. In the following, some suggested characteristics for the assessment items levels in the proposed adaptive method are displayed.

##### 6.4.1. Maximum Assessment Level for All Items Represents 100% of Verification

The changeable requirements included in the formulation of the assessment items represent the preferred performance level—as previously proposed-, which are given high and changeable scores (according to place, time, and building characteristics) when achieving them. But, if the requirements do not represent the perfect achievement, the corresponding score should not be the final score, as the final score of each item is given when only achieving 100% of the full item's verification, which is impossible sometimes for some items, but still represent it. So, the final scores and achievement level of all the assessment items will introduce the optimum Green Architecture principles which are equal to the 100% of all items perfect verification, and not the changeable preferred performance level—that are included in the items formulation-. A comparison between the proposed method and the current assessment methods regarding the maximum assessment items' level can be shown in **Table 5**, and the advantages resulting from the proposed characteristic are shown, as follows:

- Avoiding to evaluate and describe buildings as ideal when just passing the required limits given in the assessment items, even if they were presenting a good stage of sustainability.
- Preventing to equal the evaluation results for a building that only up to the limit of requirements given for an item with another building that can achieve its perfect verification.
- Ensuring that the last assessment level all the time is the final target of all the assessment items forward the Green Architecture, not only a changeable stage of it. The last level of achieving the items requirements can be called the “green level”, which can't be achieved perfectly for some items, but remains the only goal for all buildings at any place or time that everyone seeking to reach.

##### 6.4.2. Presence of Different Levels to Assess the Achievement of Items Requirements

Instead of having a certain single achievement level for most of the assessment items, it is proposed to set a number of achievement levels for all the items ending to the 100% of achievement. A comparison between the proposed method and the current assessment methods regarding some achievement items levels characteristics can be shown in **Table 5**, and the advantages resulting from the proposed characteristic can be shown, as follows:

- Avoiding to equal an item result for building that almost up to achieve the required limit given in it with a building that is far away from achieving that item requirements, as that may prevent some designers from trying to achieve such requirements by acceptable percentages when failure to reach the minimum limit of requirements, which is the maximum limit too in many items of many methods.
- Preventing the conversion of the minimum and maximum requirement limits to be the target that designers want to reach rather than the full green practice.

##### 6.4.3. Assess Continuity of Achieving Items for Various Achievement Levels

The assessment items' score in the adaptive method consist of two parts:

<sup>4</sup>For example, estimation weights for additional items that are assessing “adding new advantages to buildings (Specifications-Technologies-practices)” are calculated as a percentage from other main items' weights that already exist in the method. So first, determine the items that are benefited from the additional advantages existence, then calculate the score of the additional items by multiplying a determined percentage by the previous items weights. So when providing new specifications, technologies or practices that are distinct but are increasing the efficiency of an unimportant item (of a low estimated weight) in a specific adaptive method version, the score of the additional items is low.

**Table 5.** Comparison of the assessment items level’s characteristics between the adaptive method and the current assessment methods (researcher using Refs. [1]-[3] [5] [7] [8] [18]-[20] [23] [25] [27] [28] [30]-[32] [34]-[36]).

Comparative aspects	Adaptive method	Other assessment methods
<b>Maximum assessment items’ level</b>		
Relation to items’ requirements	The full score of any assessing item is given when only achieving a 100% (full green practice) of the item’s achievement, otherwise different scores are given. Thus, the items requirements (numbers, percentages, and standards to be followed) are to reflect the best practice can be achieved according to the possibilities and limitations for each place, time and buildings characteristics, but in return a high scores are given, but not the optimal.	Items requirements are presenting the best available sustainable practice in buildings to deal with the environment according to the different circumstances of their producing countries (similar to the adaptive method). That’s why percentages and numbers of the assessment items requirements are below the optimal practice 100%, and these items requirements are constantly changed to reflect the new limits that can be obtained, but unlike the adaptive method they get the items’ full score when just passing them. From above, it can be noticed that the items targets are moving and not unified over place and time, so buildings were previously assessed are constantly viewed differently and with a fake impression especially when getting any items’ full scores.
<b>Assessment items’ achievement levels</b>		
Existence	Maximum level represents the best practice (100% of item’s verification), while the minimum level may meet 0% or above, <sup>a</sup> and there are several levels in between, including the level of achieving the preferred performance (shown in the item’s formulation).	Most methods contain one specific level for most of their items to determine their achievement, and must be overridden to get the items scores. Some methods such as CASBEE and GBC got several levels of assessing all items, but all methods don’t represent the 100% of items’ verification to achieve the maximum score given to them.
Assessing scores	Any item gets an assessing score as long as passing its minimum achievable level, which is 0% or above for some items, <sup>b</sup> and it is rewarded in different ways according to the level of achievement.	Building doesn’t get any score unless passing a specified limit of achievement, and the given scores are unified beyond it. Besides, In the methods that have more than one level to assess items, the maximum and minimum levels are not presenting the ideal achievement and none of achievement.
Final classification	Unified for all buildings, and representing the ideal achievement, which is 100% for all the items.	Varied among different assessment methods, and among the same methods over the time, to represent a higher environmental efficiency each time.
<b>Assessment items’ continuity levels</b>		
Relation to items’ requirements	Items are assessed according to achieving their requirements during the periods of time they lasts through. Thus, it is proposed that one item may have more than one level of achievement, each of these levels will have its continuity level, so scores meeting the achievement levels will be multiplied to the scores of their continuity levels to get the final item’s score.	Assessment is not associated with the time periods that items requirements lasted through, thus, assessment depends on giving the items their scores when passing a given period of time or for the longest achievement possible.

<sup>a</sup>In the case of mandatory items, the minimum level of achievement is high, it may be 80% or 90%. Generally the minimum level of items requirements depend on the type of those requirements, and sometimes are higher than 0%. <sup>b</sup>Designers may be distracted of an item achievement when feeling unable to achieve the single minimum level given to pass it, especially when there is a conflict in achieving the functions related to that item with another one that uses the same elements in the building.

First: A score or more corresponding to an achievement level or more that can be achieved by the building for an item requirements through different time periods.

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

Therefore, in the adaptive method, 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<sup>5</sup>.

After determining the previous two parts every level score of meeting the item requirements is multiplied by the level score of its continuity for all time periods, and then the resulted scores are gathered to get the final item's score. A comparison between the proposed method and the current assessment methods regarding the inclusion of continuity levels of achieving the requirements can be shown in **Table 5**. The advantages resulting from assessing the continuity of the achievement levels can be shown, as follows:

- Capability of meeting one or more of the items' achievement levels, which will be multiplied to their continuity levels (time periods that lasts through).
- Getting more accurate results of the assessment items.

## 6.5. Proposed Characteristics of the Used Approaches of Assessing the Items

Each assessment method uses its own approaches to assess the different assessment requirements. In the Adaptive method some approaches were preferred and some characteristics were added for the used ones. In the following, some suggested characteristics for the used assessing approaches in the Adaptive method were displayed.

### 6.5.1. Assessing the Overall Building Performance as Much As Possible

Whenever it is possible to assess the wider level of the assessment components by using a simulation software, for example, the better the results expresses the building environmental performance. It was previously mentioned that the three main fields in the adaptive method are divided into several main, secondary, and sub-items, and also divided into 10 environmental functions through these fields. In the adaptive method, it is preferred to assess the wider levels than their sub components, and its proposed tool helps the assessors to start their assessment by the wider assessment levels before moving to the detailed levels. Therefore, the assessment can be done by assessing the overall functions when it is possible, or assessing the items separately. A comparison between the proposed method and the current assessment methods regarding the portability of using the overall performance to assess the items requirements can be shown in **Table 6**. There are a number of advantages when assessing the building overall performance rather than the separated items, as follows:

- Avoiding to give some items undue scores without achieving the main objective of their presence regarding their related assessment functions, which means, to prevent granting scores for the separated items to verify a function without making sure of their impact on the overall performance to achieve that function.
- Giving the different countries the ability to choose the appropriate way to assess the overall performance of every environmental function associated with their buildings, taking into consideration the various abilities for the different countries and over the time regarding the assessment software and technologies.
- Helping to recognize the continuity of achieving the items requirements to calculate the items scores easily, especially for the previously mentioned proposed way to calculate the items scores in the adaptive method.

### 6.5.2. Using Kano Model Questionnaires for Some Assessment Items

It is suggested to depend on the Kano model<sup>6</sup> for the questionnaires implementation used in the adaptive method, these questionnaires are important to continue the assessment of some items that depends on the human requirements. The Kano model do not need time or effort to be answered, as they are just two questions for each assessed requirement with given choices, its final score for each item ranges from 0 to 1 as the rest of the proposed scores in the adaptive method, which is multiplied later in the item's estimation weight to reflect its relative importance to other items. A comparison between the proposed method and the current assessment methods

<sup>5</sup>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 characteristics. Sudden variation, which is unexpected change to the environment such as earthquakes, volcanoes, floods, wars, or a radical change of a building function. (Researcher using Refs. [4] [6] [26] [38]-[40]).

<sup>6</sup>The Kano model is a theory of product development and customer satisfaction developed in the 1980s by Professor Noriaki Kano. The Kano Model's main objective is to help teams uncover, classify, and integrate three categories of Customer Needs and Attributes into the Products or Services they are developing. The three types of needs are classified depending on their ability to create customer satisfaction or cause dissatisfaction. Missing any of these needs will jeopardize the success of the offering. The purpose of the tool is to support product specification and discussion through better development of team understanding. Kano's model focuses on differentiating product features, as opposed to focusing initially on customer needs [41]-[43].

**Table 6.** Comparison of some features used to assess some items' requirements between the adaptive method and the current assessment methods (researcher using Refs. [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Adaptive method	Other assessment methods
<b>Portability of using overall performance to assess items requirements</b>	
The assessor may choose from several alternative approaches to assess the items requirements of a same function, the preferred alternative is to assess the overall performance of the building to achieve that function (by using a simulation program for instance), while assessing each sub-item separately is the least preferred.	There are usually no alternatives for the approaches used in assessing the items, and in exception of some functions like those related to the energy efficiency, the items are assessed separately by the usual and well known ways of each producing country for each method.
<b>Portability of using questionnaires to assess items requirements</b>	
Questionnaires are one of the choices that the assessor may choose from several alternative approaches to assess items requirements, and it may be used during all or certain building life stages besides repeating it during different time periods according to the environmental variation types associated with items.	Questionnaires are used to complete assessing some items after the construction stage and during operation.
<b>Portability of using text expressions to assess items requirements</b>	
Text expressions can be used to describe the levels of assessing and achieving the requirements of some items when the quantitative expression is difficult. The assessing score in these cases is given upon answers for a series of questions that experts develop.	Rarely the items that are difficult to be assessed using quantitative or mathematical equations are considered, except in some methods such as CASBEE.
<b>Portability of changing the calculations accuracy degree</b>	
Different items importance (estimation weights) may have a different accuracy degree for the calculations used for their assessment. Therefore, experts at the level of each item can determine its required accuracy degree to save their time and effort if the accuracy of an item doesn't show an impact on the final building result due its low estimated weight.	The calculations in these methods may be considered simple compared to those in the adaptive method, thus there is no great need to change the degree of accuracy of the various items included within them. In GBC method the degree of accuracy can be changed in the overall method by reducing the number of items and choosing limited ones, however, that way reduces the accuracy of the final assessment result not just the accuracy of the internal calculations.

regarding the portability of using questionnaires to assess items requirements can be shown **Table 6**, and the advantages resulting from using the Kano model questionnaires can be represented, as follows:

- Helping to speed up the spreading of the adaptive method globally, as it can be used for all regions and countries without changing the items requirements as previously proposed, because when changing the items requirements according to the different countries characteristics to assess the internal human comfort, for example, they take a very long time, so questionnaires are more helpful for such an assessment.
- Helping to deal with the items that are difficult to be described or computed by mathematical equations.
- Helping to deal with the human properties associated with individuals to obtain more accurate and credible results than the quantitative measurements, and to deal with the human differences from one person to another.
- Helping to deal with temporal variables affecting the individuals' satisfaction.
- Helping to assess the overall performance of some building' functions as previously proposed.
- Helping to recognize a conflict presence between achieving some of the human comfort functions when using the same building elements to achieve them.
- Helping to verify the continuity of achieving the items requirements by repetition questionnaires during different time periods according to the environmental variation types affecting the items.
- Helping to assess the psychological comfort which rarely appears in the current environmental assessment methods of buildings due its difficulty of being measured mathematically.

### 6.5.3. Using Text Expressions to Express the Environmental Performance of Buildings

The items requirements and their achievement levels are proposed to be expressed using text expressions when

it is difficult to be determined using specific figures. A comparison between the proposed adaptive method and the current assessment methods regarding the portability of using text expressions to assess some items requirements can be shown in **Table 6**. The advantages resulting from the proposed characteristic can be shown, as follows:

- Helping to deal with the non-quantitative characteristics (that cannot be put in the form of mathematical equations or calculations) like a lot of the environmental properties and the buildings respond characteristics.
- Helping to identify the continuity degree of achieving the various items requirements, especially for those cannot be set in numbers, but can be described.
- Helping to assess some items that cannot be assessed without using descriptive requirements and descriptive achievement levels, such as “benefiting the surrounding environment”, “Reduce environmental functions conflicts” and “building interaction with users”.

#### 6.5.4. Possibility of Changing the Calculations Accuracy Degree Used in the Assessment

Changing the calculation accuracy degree may appear in the adaptive method for the calculations used to determine the requirements of some items, determine their estimation weights, and calculate their scores. The accuracy degree can be changed in the previous calculations for each item according to its relative importance to others, by changing any of the following:

- Number of variables (variables affecting the formulation of items, the determination of their weights, and assessing levels), So, low estimated weight items may focus on the most important variables affecting the achievement of their requirements rather than exposing to all variables associated with them.
- Number of variation types (that are associated with each item to calculate the continuity of their achievement), noting that the relative importance of these types varies for each item.
- Number of spaces used for calculating the items scores, as the evaluation may be either at the level of the whole building, the level of the main spaces (according to the ratio to the total building size), or the level of every included space prototype. So, The less the item’s weight, the fewer and larger the spaces used to calculate its score.

The possibility of changing the calculations accuracy degree used in the assessment helps to save time and effort that may be consumed to include the variables’ effect of some items without making differences in the total result. A comparison between the proposed method and the current assessment methods regarding the portability of changing the calculations accuracy degree can be shown in **Table 6**.

#### 6.5.5. Gradient in the Spatial Scale of the Assessment

Versions of the adaptive method are proposed to suit the spatial characteristics of the assessed project as much as possible, thus, the assessment versions can be designed for each specific project, but first, they should be gradient from the country spatial scale. The versions of the wider spatial scale are used in forming the more specific ones, versions designed for each country can be used to design the versions of its internal climatic zones, then their internal cities or villages and then for their internal project sites. Thus, the time and effort spent in each specific version are overlapped with those of the wider versions, as they are not started from scratch. Each project can be assessed by any of the spatial versions of its country, but the more the version is specified, the more the results are accurate and trusted. A comparison between the proposed method and the current assessment methods regarding the portability of having different spatial levels of assessment can be shown in **Table 7**, and the advantages resulting from that proposed characteristic can be discussed, as follows:

- Ensuring the maximum fairness in the assessment results when assessing building in a specified spatial level.
- Dealing with the varied spatial characteristics in the same country at all levels of detail.
- Ensuring the assessment inclusion of any requirements or specifications associated with one place without the other, which avoid using incompatible items to assess some projects.
- Helping governments to implement the obligation of submitting the environmental assessment certificates within the building permits without fearing their injustice results.
- Give an enough chance and time before obligating the environmental assessment certificates of buildings, which copes with the time-consuming of the composition gradient from the country scale version to the detailed scale versions.

#### 6.5.6. Possibility of Expressing the Final Assessment Scores in Different Ways

Expressing the final assessment scores in the adaptive method may appear in different ways according to the as-

sensor choices. The final assessing score may be:

- The result gathered from all items scores with determined success requirements, including a minimum degree of the Building Environmental Efficiency (BEE) indicator.
- The (BEE) indicator with determined success requirements, including a minimum limit of the gathered items scores.
- A mixed result of the gathered scores result and the (BEE) indicator result, with an equal or different percentage for each.

A comparison between the proposed method and the current assessment methods regarding the flexibility of expressing the final assessing scores can be shown in **Table 7**. Advantages resulting from the proposed characteristic can be shown, as follows:

- Helping and encouraging the spread of the adaptive method across the world, in spite of the different current ways of expressing the environmental performance of buildings and the final assessment scores in the different methods of the different countries.
- Helping the possibility of comparing the assessment results between the buildings assessed by the adaptive method and other buildings across the world, especially those assessed by the CASBEE method and other methods depended on it.

### 6.6. Proposed Characteristics for the Building Success Requirements

It is notable that each method has its success requirements, these success requirements include deferent limits and mandatory requests in the deferent assessment methods. Some suggested characteristics for the building success requirements in the adaptive method are displayed in the following.

#### 6.6.1. Require Achieving a Minimum Determined Degree of Environmental Building Functions

The proposed ten environmental functions that the main three fields of the adaptive method were suggested to include, are included in the following:

- Achieving physical, chemical, and biological equilibrium for the surrounding environment of the building.
- Achieving balance with the dynamical variations in the surrounding environment of the building, achieving building life cycle integration.
- Achieving efficient consumption of resources.
- Achieving physical, chemical, radical, and physiological equilibrium of human dealing with the building.

Exceeding a minimum determined degree for these ten functions is proposed to be a success requirement in the adaptive method. A comparison between the proposed method and the current assessment methods regarding that success requirement can be shown in **Table 8**, and the advantages resulting from the proposed characteristic can be displayed, as follows:

**Table 7.** Comparison of some features used to determine the assessment final score between the adaptive method and the current assessment methods (researcher using Refs. [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Adaptive method	Other assessment methods
<b>Portability of having different spatial levels of assessment</b>	
The method versions are designed to be gradient for each country from a level used to assess the country as a whole to a level that can assess a certain project, passing through several levels in between (climatic zone, city or village, region, project).	Different methods are designed to assess any building in their produced countries as a whole, regardless of the differences between regions characteristics except in some calculations related to energy consumption and thermal comfort and other limited calculations.
<b>Flexibility of expressing the final assessing scores of buildings</b>	
The main way of showing the building final score is by gathering items scores and taking into consider a success limit of a minimum BEE indicator achievement. There are also other ways of showing the final score such as the BEE indicator itself beside a minimum limit of passing the gathered items scores, or according to a mathematical equation of both the BEE indicator and the gathered items score. So it is possible to compare any building that uses any other assessment method with those uses the adaptive method.	Most methods show their final building score by gathering items scores, while CASBEE method depends on the (BEE) indicator. Therefore, it is impossible to compare results of some methods with others.



**Table 8.** Comparison of some success requirements between the adaptive method and the current assessment methods (researcher using Refs. [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Comparative aspects	Success requirements' characteristics	
	Adaptive method	Other assessment methods
Success requirements	Mandatory items that defer according to different variables affecting every version. Minimum total score (uniform in all versions). Minimum limit for all environmental functions. Minimum limit for the two bases of the Building Environmental Efficiency (BEE) indicator.	Minimum total score (varies between different methods and for the same method over time) beside another non-uniform set of requirements between methods, such as: Mandatory requirements should be passed. Minimum number of mandatory items to be achieved. Minimum score to be passed for every assessing field.
Relationship between success requirements and Green Architecture principles	Includes a minimum score for all environmental functions which are covering all Green Architecture principles, so when assessing the building or modifying the estimation weights of the items to reflect the different variables effect, these functions remain within an accepted limit of achievement.	Usually the same items that are previously got high estimated weights due to their importance versus other items are the ones controlling the success of buildings, thus a building can succeed without achieving one of the Green Architecture principles which may be included in the assessment through unimportant items with a low estimation weights.
Usage of the Building Environmental Efficiency (BEE)	Uses a minimum limit degree of achieving the two bases of BEE to allow the building success, BEE indicator can also be used to express the building final score and classification when needed.	CASBEE uses BEE to express the buildings' final score and classification.
Possibility of determining BEE at the detailed levels of assessment	Every detailed item is expressed according to one of the BEE sides, they are either helping to achieve quality (Q), reducing the environmental load (RL), or both with a certain percentage. So, for every item or field in the adaptive method a BEE indicator can be calculated showing its efficiency.	In CASBEE, each of the main six fields included in the method are related to one of the BEE sides, They are either expressing the achievement of quality or the reduction of environmental load. So, the BEE indicator can only rise at the end of the assessment.

- Giving a governor relationship when changing the items estimation weights, to keep the assessment process balanced with a minimum limit of concern for all environmental building functions, in spite of the different variables affecting the method's versions which lead to change their components weights.
- Avoiding to use the same important items that takes a high estimation weights to control the success of the building and its classification-as in other assessment methods -, while there is a possibility of ignoring other items that are connected to other environmental functions, which may be less important through the assessed time period.
- Taking into concern a minimum level of attention to all environmental functions associated with the Green Architecture, therefore, ensuring that any green function is in an acceptable range of attention that shouldn't decline beneath.
- Avoiding success of buildings that are not achieving all Green Architecture principles within an acceptable range.

### 6.6.2. Require Achieving a Minimum Determined Degree for the Two Bases of (BEE) Indicator

The two bases of the Building Environmental Efficiency (BEE) indicator are achieving quality (Q) and reducing environmental load (RL). These bases are forming the assessment way and the final score of CASBEE-and other methods depended on it-. In the adaptive method, these two bases are used in a different way from CASBEE but with the same calculations and meanings. The adaptive method benefits from them by ensuring the building efficiency too. Exceeding a minimum determined degree for these two bases is proposed to be a success requirement for the buildings assessed by the adaptive method. A comparison between the proposed method and CASBEE regarding some characteristics of the (BEE) indicator used in both of them can be shown in **Table 8**, and the advantages resulting from the proposed characteristic can be shown, as follows:

- Helping expressing the relation between the building and the environment using the (BEE) indicator, which is the best current way of expressing that relation. It gives a minimal attention of achieving both quality and

environmental load reduction for each building, and afford additional points when increasing them according to determined degrees too.

- Achieving a balanced evaluation process between Q and RL, in spite of changing the items estimation weights due to variations associated with them to produce the deferent assessment versions.
- Avoiding to limit the same items that are given high estimation weights in a version to control the success of the building beside its classification, especially when they are only expressing one of the two BEE bases, while ignoring some other environmental issues that contain lower weighted items, but almost comprehensive the other BEE bases.

### 6.7. Proposed Characteristics of the Accreditation Institution of the Adaptive Method

It is suggested that the accreditation institution responsible for forming and issuing the adaptive method versions is global and unified for all countries. That Proposed characteristic of the accreditation institution helps to get several benefits in order to achieve credibility and fairness of building assessment results and comparison rather than dealing with results from different sources when relying on more than one council or institute to form and modify the same method. New problems may arise when unifying the accreditation institution such as the difficulty of finding experts from different countries of the same level of qualification. These difficulties and the suggested ways of treating them are displayed later in the research. The expected advantages resulting from unifying the accreditation institution of the adaptive method can be discussed, as follows:

- Avoiding the different stringent levels of the producing institutions of the environmental assessment methods of buildings of the different countries, which doubt the fairness of the assessment comparison results among them, and doubt the presence of an indulgence assessment in any of these countries. Even the Green Buildings Councils around the world have no guarantee of a uniform stringent level of composing various versions resulting therefrom.
- Avoiding the experience confliction of experts involved in forming and modifying the same version of the assessment methods. That confliction occurs in the international versions when local experts of local institutions complete or modify the origin method issued by another institute.
- Avoiding to produce different assessment certificates for the same place or country with different characteristics when relying on different institutions for that.
- Saving the time wasted among several producing institutions to produce any version, as for the international versions that are produced by local institution beside the origin ones for approval after emendation.
- Saving the time consumed to form the local methods for each country separately, without benefiting the time and effort spent on others. As the unified institution helps to benefit from the experience, effort and time spent in forming various versions through new ones, where you can use some of the data and input from a version in the other, especially when there are similarity of some variables affecting those versions such as similar climatic zone, time period, or building type.
- Gathering experience from the adjustment and the feedback of different designers, assessors, experts, owners and users of the buildings, which would reduce the time spent in developing and composing versions, and help the ease of deployment.
- Having a certain competent authority for the obligation of any international conventions or treaties associated with Green Architecture with an equal level of commitment around the world.
- Helping to enforce a minimum environmental level around the world, thus, encourage the obligation of the environmental assessment of buildings within the building permits by the different governments according, to a global application and implementation.
- Unifying the importance level of the most concerned global issues among the different countries during each different time period.

The presence of local experts in the composition of various versions of each country may help achieving more advantages, as follows:

- Including the effect of the spatial variables-especially those associated with human characteristics (as culture and habits)-with the utmost precision and credibility in the composition of the method versions.
- Exchanging experiences and cultures, and extracting ideas that may appear when forming different versions around the world.

- Avoiding the impact of experts’ priorities that follow a certain country on the formation of method versions for other countries-these priorities may include market requirements, policies and economics -, besides preventing the dominance of a specific culture on the worldwide practice and application especially for countries that don’t comply with.
- Helping to gradient the assessment method through the different spatial levels among the world, which require knowledge of the different countries characteristics that can be obtained from the different local experts.

A comparison between the proposed method and the international versions regarding some characteristics of their accreditation institution can be shown in **Table 9**.

## 7. Advantages of the Adaptive Method

In the following, there will be a focus on the differences between the adaptive method and the international versions of LEED and BREEAM besides the GBC method, as these methods are considered the rivalry ones that have the same concept to deal with the variables affecting the environmental assessment of buildings to help a more accurate results when spreading them globally. Some of the main advantages of the adaptive method versus the previous methods are as follows:

- Having the capability of assessing the continuity of meeting the items requirements for their levels of achievement.
- Ability of addressing items that weren’t addressed before in spite of their relation with Green Architecture due to their difficulty of being assessed quantitatively, such as assessing the “psychological needs of users” and the “ability of buildings to benefit the surrounding environment” (Researcher using Refs. [8] [19] [25] [27] [28] [30] [32] [34]-[36]).
- Dealing with all variables that may affect its components rather than focusing on specific spatial variations as in the international versions of LEED and BREEAM, or using just four fixed characteristics as in GBC method to describe all variables effect on the items estimation weights without differentiating variables and their importance for different items (researcher using Refs. [10]-[19] [21] [23]).
- Ability to change the complexity degree when including variables effect or dealing with them for each item according to its relative importance to others (estimated weight), that helps to save time and effort may be consumed without the emergence of accuracy resulting from some calculations on the total final result, considering the more than the usual steps to ensure accuracy of results in the adaptive method.
- Unifying the final score relation with the full sustainability achievement in buildings (100%), while other methods’ final scores depend on assessing the best available sustainable practice that could be achieved in their producing countries. Thus, achieving the full score in the adaptive method is impossible, but it is preventing a wrong expression for the level of sustainability achieved by buildings according to the obtained results versus the inconstant sustainable target in the other methods, especially with the time passage.
- Keeping the assessment goal clear and comprehensive over the time through the assessment fields, as the adaptive method uses the main environmental equilibrium relationships associated with buildings to express the assessment fields included in it, rather than using separated environmental issues that vary between different methods and may be changed over time for the same method, as in LEED, BREEAM and their international versions.

**Table 9.** Comparison of the accreditation institutions’ characteristics between the adaptive method and the international versions (researcher using Refs. [10]-[13] [21] [23]).

Accreditation institution’s characteristics	
Adaptive method	International versions of LEED and BREEAM
A unified accreditation institution for forming and issuing various versions for all countries, different time periods, and different building characteristics, which includes experts from all countries in a specific level of qualification.	Make use of local institutions for emendation along with the origin ones, such as the green building councils around the world, but, keeping the amendments of the local experts’ emendations are up to the origin institution, and may be re-modified couple of times in order to maintain consistency with the origin versions of the method, which consumes a lot of time and effort and may cause experience conflict between the two emendation parties.

- Keeping the assessment fields in the adaptive method fixed despite their internal changes in their items' weights and formulation. On the other hand, LEED, BREEAM and their international versions have the ability of changing their assessment fields over the time, which prevent the capability of comparing buildings of the same methods over the time. In GBC method, there is an ability of deleting some assessment fields in different assessment stages between the different countries, which causes more difficulties to obtain a fair compared among buildings of different versions over the time and place (Researcher using Refs. [10]-[19] [21] [23]).
- Enabling changes without limits linked to a certain method trademark or institutional commitments as in the international versions of LEED and BREEAM (researcher using Refs. [10]-[13] [23]).
- Considering the assessment environmental balance when changing the estimation weights of the assessing items, as it ensures a minimum success limit for all environmental functions after modifying its items' weights to, and ensures a minimum success limit for the two bases of the Building Environmental Efficiency (BEE) indicator. So, it prevents the possibility of marginalization any environmental issue included in Green Architecture principles, as may happen in the other methods that use the same assessment fields that got high weights to control the building success limits as well.
- Containing several success requirements to ensure the concerning of all the environmental functions associated with buildings, and ensures the balance in achieving the two main bases of the building environmental efficiency (BEE) indicator. A determined, unified minimum limit for achieving the environmental functions and a determined, unified minimum limit for the BEE bases help not giving priority for one or two environmental issues while disregarding others. These limits should be set to help remaining them in an equal minimum concern. Other methods takes into consider success requirements that are linked by the same environmental functions already gets higher weights. GBC method has no success requirements, so when lowering the assessing field's weights contained within, there is a possibility to marginalize some of them during amendment (Researcher using Refs. [14]-[20]).
- Considering the effect of time variables for each time period to allow a fair comparison over the time. So, there is no need to upgrade the assessment results according to any new versions, as those results were calculated according to the same final target for all versions over the time, due to the fixed maximum achievement level (100%) of all items, despite differences occur in the scores given to the different items achievement levels that defers according to the time variables to reflect the time effect.
- Allowing the use of any standards, lows or codes without being adhered to a specific level or references as long as its accreditation institution approved any, which allows flexibility in dealing with different standards such as those for specific countries or other international standards or combination of them when needed. Taking into consider that the stringent level of these standards, lows or codes is a variable that effects raising or lowering the estimation weights of the assessment items that are using them. There is a possibility of using local standards in GBC method too, but their stringent level didn't have an impact on the assessment as in the adaptive method (Researcher using Refs. [14]-[20]).
- Allowing the presence of multiple alternatives to be assessed when modifying the formulation of the assessment items, which allow compatibility with all circumstances that may face the designer or solutions that may be resorted to. So, instead of having a specific formula either to be achieved as it is to get a score or not at all, the adaptive method helps achieving the items requirements by multiple ways that succeed in, which expand the given solutions for buildings when designed, taking in consider the variety of scores granted to those alternatives according to their rigor degree.
- Relying on one independent accreditation institution with no other post hand to develop its versions as in the international versions of LEED and BREEAM, so there is a guarantee of preventing the influence of other country's priorities on the country that the version is produced for. Taking into consider the inclusion of that institution of local experts from all over the world with a minimum required experience (Researcher using Refs. [10]-[13] [21] [23]).
- Considering-when there are more than one variable affecting an item-the importance ratios of the different variables effect on the same item when calculating their estimation weights, which helps to separate and study the variables influence on the assessment items separately.
- Using several levels to assess the items requirements ranging from 100% of verification to zero% (some items have a minimum achievement level that is higher than zero%, especially for the chosen mandatory items, as they start from a high achievement level (85%-90%)). Those levels are awarded by different scores

according to their achievement degree, while most other methods use only one level to assess the achievement for most of the items. CASBEE and GBC methods contain several levels to assess all items, but the maximum level doesn't represent the ideal verification 100%, Besides the minimum level in GBC represents a negative practice with a negative score (-1) that meets sometimes a positive achievement not a harmful one, but lower than determined (Researcher using Refs. [8] [14]-[17] [22] [24] [25] [27] [29] [31]-[33]).

- Allowing to use achievement levels that are various in number and values between the assessment items-except the maximum level's value of meeting 100% of achievement for all items-, which gives a flexibility to meet different items and variables properties (spatial, temporal and building characteristics) affecting the assessment. On the other hand, the other methods that are using multi-assessment levels are unifying them in number and values, as in GBC that have four levels of unified scores (-1, 0, +3, +5) regardless the differences between the items and the variables affecting the assessment (Researcher using Refs. [14]-[20]).
- Allowing to change the formulation of its items through its detailed levels by amending certain determined parts of those items. This operation saves time and effort and prevents duplication of work when amending the method to produce new versions to fit with the different variables. Other methods don't consist a prior way to amend items formulation according to different variables affecting them.
- Collecting the greatest possible number of specialized and non-specialized items for all buildings and various circumstances similarly to the GBC method, which allows choosing from those items when needed, and delete unneeded items according to the different variables affecting them. The international versions of LEED and BREEAM rely on reducing the specialized items from the first beginning, so local experts may add items that were contained before but with the ability of experience confliction between origin and local experts. Thus the adaptive method avoid losing the consumed experiences, time and effort, especially the wasted time resulted from sending requests between origin and local institutions to produce local versions from the international ones (researcher using Refs. [10]-[21] [23]).
- Forming different versions of different spatial levels, starting from the country level down to the project level. That feature helps governments to obligate the provision of the environmental efficiency performance proof within the building permits without any fear of unfairness, in addition, it gives the opportunity and enough time before the obligation to ensure the utmost evaluation fairness. GBC method includes a similar idea by configure a master file of a specific area (File A) then creates a set of (B files) for each project (researcher using Refs. [14]-[20]).
- Allowing to express the final score in different ways, such as by gathering the items scores or by calculating the Building Environmental Efficiency (BEE) indicator, with using the other way as a success requirement. That feature helps spreading the method across the world, as it helps comparing the environmental performance of buildings between all different countries, especially for countries that uses BEE to express their buildings final score, such as Japan and China.
- Attracting the attention of multinational companies to use it globally. Theoretically, these companies may prefer the use of known and relevant methods such as LEED and BREEAM to evaluate their buildings to proof their environment interest, but applicably they will be forced plenty of times to change the method they are using according to the country in which they go, and the available or preferable methods in these countries, which waste time and effort to deal with each different method each time. The adaptive method may consumes initial time and effort to get used to it, then it easily moves anywhere by amending it according to certain steps to include the different countries variables affecting the evaluation.

In the following, some comparative aspects between the adaptive method and other assessment methods are introduced in **Table 10**, which helped the adaptive method to achieve some of its advantages.

## 8. Defects of the Adaptive Method and Proposed Ways of Treatment

Beside the previous advantages, there are a number of defects that the adaptive method may suffer from. In the following, some main defects of the adaptive method and their proposed ways of treatment are discussed as follows:

- The adaptive method faces a spread challenge versus the international versions of LEED and BREEAM, as a result of their association with huge experience institutions with widespread practice in environmental assessment of buildings field such as USGBC and BRE. Thus the adaptive method needs unknown time period of experience and development before rival other methods.

**Table 10.** Comparison between the adaptive method and some current assessment methods regarding some main aspects (researcher using Refs. [8] [18]-[20] [25] [27] [30]-[32] [35] [36]).

Comparative aspects	Local methods (LEED, BREEAM)	International versions from LEED or BREEAM methods	GBC method (SBTool)	Adaptive method
Unified main assessing fields over the time	X	X	X	√
Possibility of adding new items when needed	√	√	X	√
Several achievement items' levels for assessment and several corresponding scores	X	X	X	√
Ability of changing the items formulation	X	√	√	√
Covering all items that may be exposed to	X	X	√	√
Calculating items estimation weights mathematically	X	X	√	√
Possibility of re-use some estimation weights	X	X	X	√
Success requirements not focusing the high weighed items	X	X	X	√
Ability of expressing performance by text expressions	X	X	√	√
Possibility of changing the assessment accuracy degree	X	X	X	√
Ability of expressing the final buildings scores in different ways	X	X	X	√
Ability of getting different spatial scales of assessment	X	X	√	√
Assessing the continuity of achieving the items requirements	X	X	X	√
Accepting all standards and codes by including their rigor degree in the assessment	X	X	X	√
Not linked to certain trademarks and nonlocal limits	X	X	√	√

However, it could in turn compensate the time spent to gain experience quickly by depending on its electronic tool for application, and then focus on developing the way of including variables effect on the evaluation instead of wasting time and effort producing new versions, as in LEED and BREEAM international versions. It is noted also that the previous international versions rely on the experience of one key institution, however, the adaptive method can benefit from the local knowledge experience of any country as well as any other institution or previous methods without being restricted to a certain one.

- The adaptive method faces an advertising challenge versus the international versions of LEED and BREEAM, as a result of their strength in marketing their publications.

However, the adaptive method can be linked to green companies' websites, which will help spreading the adaptive method and presenting it to the public when using these websites, and in return, the adaptive method may include their latest technologies, which can be found in the adaptive method variables data, that the experts use to adapt the versions if approved.

- The adaptive method consists several steps to ensure fairness than usual in other methods, therefore the adaptive method theoretically is more difficult to deal and more time-consuming than other methods.
- However, the use of the proposed electronic tool helps the ease of dealing with the adaptive method, taking into account other set of features to reach that, such as the possibility of re-using the estimation weights of items previously determined according to the variables effect, and the possibility of changing the complexity degree of calculations used in the assessment for each item according to their importance. Noting that familiarity of experts and assessors of the way the method works is the basis for saving time in the future significantly. Assessors may reach the experience of dealing with the adaptive method quickly, as their assessing steps appear in the form of multi choices that may include text expressions to help accurate and quick assessment.
- The configuration of a unified accreditation institution for composing the various versions of the adaptive method needs unknown time, which may delay the work with the method.

However, to save time, an existing and neutral institution may be temporarily responsible to configure different versions of the adaptive method with the assistance of local and international institutions to provide specialists in the field of environment, energy and buildings with a minimum limit of experience, until configuring an accreditation institution with a specific level of requirements for experts.

- The difficulty of collecting experts from different countries around the world within the accreditation institution in an appropriate time.

However, direct communication can be initially determined around the world to these experts by an appropriate network until gathering them in one institution.

- The differences in the experience level between the different countries may represent an obstacle in finding experts from all of them in the same degree of competence to be included in the accreditation institution, which may lead to depend on a few countries to get experts. But that solution may cause the same problems appeared when relying on experts from one country as in the international versions of LEED and BREEAM, such as losing the guarantee of versions independent from these countries priorities and interest.

However, experts of spatial characteristics of the countries that don't have experts of the required experience level can be added initially until getting the appropriate experts from those countries. Taking into account the allocation of an appropriate mechanism for training and rehabilitation experts around the world according to the required level to be included over the time.

## 9. Results and Conclusions

In line with the growing interest of the environmental assessment of buildings, and the importance of its accurate results, a number of international versions were introduced to be compatible to the different spatial characteristics around the world, such as LEED International and BREEAM International. GBS method and its electronic tool, SBTool, were appeared to help third parties to produce their own assessment versions locally. On the same pace the adaptive method was proposed to overcome the different disadvantages occurred in the previous methods, and introduce a number of features to help a more accurate assessment. The research arrives to a number of results, as follows:

- There is a range of spatial and temporal variables that must be taken into account when assessing buildings environmentally to ensure fairness of the evaluation results.
- Differences between methods put limits to compare the results of environmental assessment of buildings in a fair and accurate manner among different countries.
- Despite the global need for spreading the environmental assessment methods around the world, they fail to deal with variables affecting the assessments when using them out of the temporal and spatial regions they were designed for, thus they lead to insufficient assessment results.
- Some current solutions to transmit methods all over the world is using the international versions of some well-known methods (LEED-BREEAM) or using the SBTool to create local methods. But despite them dealing with some different countries characteristics they possess deficiencies in their way of implying the impact of many other variables which causes a reduction of the utmost accuracy and fairness of results.
- Creating local methods from scratch for each country faces a number of obstacles, such as the need for a long time to be created and modified and the difficulty of competing other well-known and widespread methods locally.
- An adaptive environmental assessment method for buildings is proposed to be used globally. It is characterized by a number of characteristics that helps to increase the accuracy of its results when moving across different spatial and temporal regions, and for different building types. Some of these characteristics are:
- Unified main assessing fields for all versions and over time, reflecting the main environmental equilibrium relationships with buildings, to guarantee the holistic objective of the assessment rather than focusing on a set of changeable priorities over time and place.
- Possibility of adding new items within an additional assessing field, to help including temporal and technological variations in the assessment when occur or needed.
- Ability of changing the formulation of the assessment items, by changing the phrases in items context that express the items requirements either in numbers or standards.
- Covering all items that may be exposed to, to keep and benefit from the experience of other methods and to prevent a contradiction among different experiences.

- Converting all items estimation weights into percentages and unifying the overall weight of buildings to be 100%, to help comparing buildings assessment results whatever the included variables effect.
- Linking the determination of items estimation weights with the variables effect on each of them, with the possibility of calculating the effect for more than a variable and the possibility of differentiating variables' relative importance of each item.
- Possibility of re-use estimation weights previously determined for some items by using relationships between the pre-determined weights of some items and weights of other items associated with them, to save time and effort and avoid duplication of work.
- Maximum achievement level for all items represents 100% of verification, to avoid the possibility of considering buildings ideal in verifying any item just because they only pass the maximum limit determined for the item's achievement if below 100%.
- The presence of different levels to assess the achievement of items requirements, to avoid the equality of evaluation for two buildings: one is too close to achieve the single determined investigation limit and the other is too far from it.
- Including the continuity of achieving items for various levels of achievement, to differentiate buildings assessment results according to the continuing to achieve the requirements of items.
- Preference of assessing the overall performance of the building items, to help determining the continuity level of items achievement, and to avoid granting degrees due to separate items without making sure of their impact on the overall performance of the building.
- Using questionnaires to help getting results of items associated with human needs.
- Using text expressions to express the levels of achieving items requirements and their continuity levels when cannot be put in the form of specific numbers, but can be described.
- Possibility of changing the calculations accuracy degree used in the assessment, to help save time and effort, which may consume to include the effect of variables without the appearance of that effect on the final assessment result.
- Possibility of gradient in the spatial scale of assessment, starting from a version to assess the country as a whole to a version of a specific project, to ensure the highest degree of justice when dealing with diverse spatial characteristics in the same country.
- Possibility of expressing the final scores in different ways, to help the spread of the adaptive method across the world with its different cultures, without affecting the possibility of comparing the assessment results.
- Requiring a minimum determined degree for the main environmental building functions and for the two bases of (BEE) indicator, to help, the presence of governor relationships to the amount of change in the estimated weights of items, and to maintain the balance of the evaluation process in spite of the changeable concerns associated with their requirements.
- Unified accreditation institution for all countries, to avoid different degree of rigor for different countries institutions, to avoid expertise conflict, and to prevent the loss of time between different institutions responsible for producing the same version.
- Relying on experts from different countries to help including the effect of spatial variables with the utmost accuracy and credibility, to exchange experiences, and to avoid overriding certain country's priorities and culture on other countries.
- An adaptive environmental assessment method of buildings is proposed to include the impact of variables (spatial, temporal and building characteristics) to create different versions according to them. This method versions can be created by first determining the variables associated with each item, then determine the effect of them on the formulation of those items, their existence, their rigor degree, their estimation weights, the building success limits, the items achievement levels, the items continuity levels, and the achievement and continuity levels' parallel scoring.
- If the adaptive method and its tool were properly developed, they would help getting more accurate assessment results of buildings in expressing their environmental efficiency than the current methods, ensuring maximum justice of the evaluation, ensuring fairness of comparing assessment results according to all variables, helping to spread the environmental assessment globally, providing an important element for the environmental assessment commitment around the world, helping the competition among different regions, and helping many countries that do not have a local method to overcome the delay in that direction.



- If the adaptive method and its tool were properly developed, they may help spreading the environmental assessment globally according to an equal level of environmental efficiency for buildings. Thus, they may help many countries which do not have a local assessment method to overcome the delay in the environmental assessment of buildings field, and help all countries to bind the environmental assessment of buildings through them without fearing the usage of an inappropriate method with its characteristics.

## 10. Recommendations

The introduction of the adaptive method through that research was to introduce a proposed helpful method to get more accurate environmental assessment results of buildings, and still this method under development. Thus, a number of recommendations were set as follows:

- Institutions, organizations and councils involved with the environmental assessment methods of buildings around the world are recommended to depend on the adaptive method for the environmental assessment of buildings.
- Research organizations are recommended to develop the adaptive method to help it rival for other well-known and wide spread methods.
- Institutions, organizations, and councils involved with the environmental assessment methods of buildings around the world are recommended to develop the initial version of the electronic tool designed to apply the adaptive method, and to put it electronically linked to their sites to help improving it and get the appropriate feedback.
- Different media are recommended to spread environmental awareness and the importance of the environmental assessment of buildings around the world, to provide the constituents of public feedback, to develop the assessment methods, and to raise the global environmental concern.

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