ISBN 978-93-84422-50-9
Proceedings of 2015 International Conference on Green Buildings, Civil and Architecture Engineering (ICGBCAE'15)
Dubai, Dec. 25-26, 2015 pp. 29-36

Towards Sustainable Hospitality in Egypt: Increasing Indoor Air Quality

Mona Azouz

Lecturer, Housing and Building National Research Center, Giza, Egypt

Abstract: *Indoor air quality is now considered one of the most recent and important topic in the sustainable movement, as it has a direct impact on the human health and his quality of life. This research is a part of developing Green Pyramid Rating System for Hotels (GPRS-H) in Egypt to promote the transformation of the mainstream hotels industry towards more sustainable practices. The aim of this research is developing a tool for the assessment of indoor air quality in hotels to guarantee high indoor air quality under hygienic perspectives. The research was based on the comparative analysis of indoor air quality in two International Certification Systems; the German Certificate for Sustainable Buildings (DGNB for Hotels) as the first sustainable assessment certificate for hotels and the Leadership in Energy & Environmental Design (LEED for Hospitality) as the most famous and widely applicable system worldwide. As a result an excel sheet for indoor air quality assessment is developed based on qualitative and/or quantitative criteria and indicators that address control of contaminant sources to minimize risk to indoor air, providing appropriate and sufficient ventilation dilution of contaminants and indoor air quality assessment through testing of indoor air and the monitoring of the indoor air quality. As a conclusion being in an initial stage, some indicators still could not be evaluated at the meantime in Egypt .This raises a basic question as to what necessary steps must be taken for the adaption of the system and its dynamic development, with the continuous significant re-appraisal of the system and the parallel completion of the data required for the evaluation of these indicators.*

Keywords: *Indoor Air Quality, Sustainable Hotels, Sustainable Rating Systems for hospitality, Low emitting building materials, Indoor Air Quality Assessment.*

1. Introduction

Nowadays, there is a growing trend towards sustainability in tourism sector all over the world, to reduce the negative impact of this sector on our planet. Because of the significant role of tourism in the national economy of Egypt, the shift towards sustainable tourism, is no longer a luxury, but has become an urgent necessity to maintain regional competitiveness and place Egypt as a sustainable tourism destination. As a result, a sustainable rating system (GPRS-Hotels) was established by Housing and Building Research Center's (HBRC) team with the technical assistance of consultants and auditors with practical experience in the application of the German Certificate for Sustainable Buildings (DGNB) System. The developed rating system could be used as a technical guide for qualified and licensed GPRS_H Assessors to complete the assessment, as an aid for GPRS_H Auditors to achieve the desired GPRS_H rating and as a reference for the client whose proposed hotel is to be assessed. This paper focuses on indoor air quality which has been the most recent topic considered in the sustainable movement nowadays, as it highly influences the status of human health. Sustainable hotels with high indoor air quality not only protect the health and comfort of the occupants, but also enhance productivity, decrease absenteeism of workers and improve the hotel's value as well. The performance of indoor air quality will be considered through building and construction phase.

2. Research Objectives

The indoor air pollution has become a challenging problem of the modern era which has a very serious impact upon human health, that's why the aim of the research was to develop practical tool for the assessment of indoor air quality in sustainable hospitality buildings and; to provide a healthy indoor air quality for building occupants and visitors through;

- Encouraging the use of low emission adhesives, sealants, and paints, coatings, flooring and ceiling systems and to mitigate the health risks associated with the emissions from building products;
- Providing sufficient air ventilation and protect the quality of air drawn into the building.
- Eliminating exposure of building occupants to the harmful effects of tobacco smoke, the risk of Legionella in water based building systems and other pathogens;
- Implementing construction practices that promote a high degree of indoor air quality (IAQ) for construction workers and building occupants and to facilitate the provision of adequate air quality within enclosed car parks.

3. Method

This paper focuses on the indoor air quality in hospitality buildings through a comparative analysis of the first two rating systems for hotels: the German Sustainable Building Certificate (DGNB) for hotels and the Leadership in Energy and Environmental Design (LEED) V4: Hospitality, from the indoor air quality point of view.

3.1. DGNB for Hotels

The “German Sustainable Building Certification” emphasizes an integrated view over the whole life-cycle of the building and is based on the three classic columns of sustainability: ecology, economy and social aspects in planning, construction, and operation of buildings in Germany. In addition to them there were created two cross section categories targeting aspects of the technique and of the process. The location is assessed in an extra grade, as shown in fig: 1. An assessment relies on 63 criteria (there are currently 49 from 63 criterions activated and distributed into six categories and each category is weighted in the overall score of the building. In the criteria are listed the indicators that are evaluated either qualitatively or quantitatively. Each criterion has a value of ten points. To ensure flexibility of the assessment, each criterion can be weighted depending on the relevance for the building type from 0 to 3.

Indoor air quality in DGNB for Hotels: In the DGNB for Hotels, there are two criteria that have a direct effect on indoor air quality and without the fulfilment of the minimum requirements of these only two criteria the building could not be certified. In addition there are 20 credit points could be achieved. These criteria are:

- Criterion 6 : Risks to Local Environment in Ecological Quality Category.
- Criterion 20: Indoor Hygiene in Social - Cultural Category.

3.2. (LEED) BD+C: Hospitality

LEED V4 includes the very first LEED rating system for hospitality which went live in November. It has taken an unprecedented stand on human health. Enhance individual human health and well-being was one of the main LEED's goals which were referred to as "impact categories" that have been selected to provide the framework for the technical development of LEED version 4. LEED BD+C: Hospitality system is subdivided into six categories and weighted by points as shown in fig: 1. Categories contain prerequisites that are obligatory and credits which are free to be achieved. Altogether there is a gain of 110 points in 43 credits. Additionally 12 prerequisites have to be fulfilled [1].

Indoor air quality in LEED V4- Hospitality: For Indoor air quality assessment in LEED V4-Hospitality, there are 8 possible points and 2 Prerequisite requirements. All Prerequisite & Credits related to indoor air quality are found in Indoor Environmental Quality (EQ) Category, they are:

- Prerequisite: Minimum indoor air quality performance.
- Prerequisite: Environmental Tobacco Smoke Control.
- Credit: Enhanced indoor air quality strategies.
- Credit : Low-emitting materials.
- Credit: Construction indoor air quality management plan.
- Credit: Indoor air quality assessment.

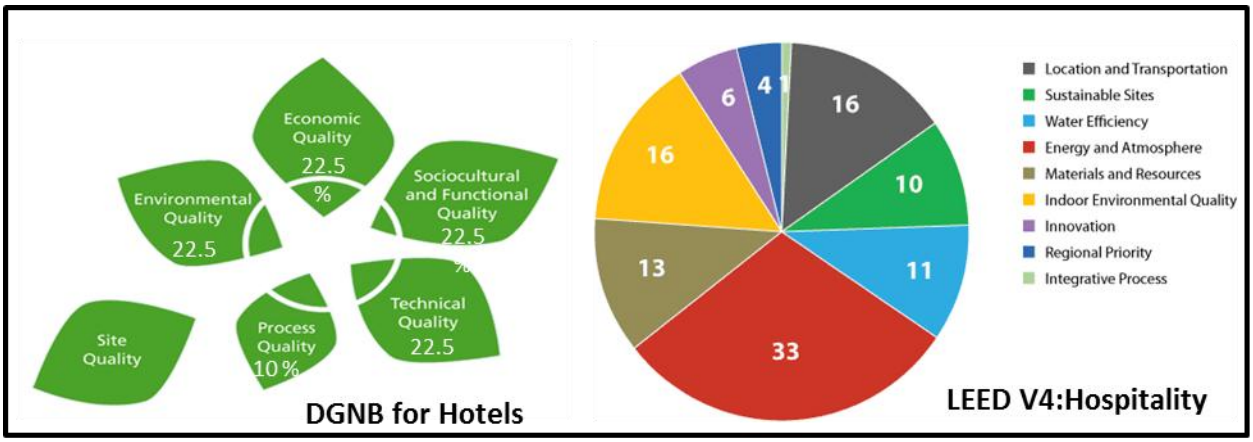

Fig. 1: The percentage of different categories in DGNB and possible points for each category in the LEED

3.3. Comparison between indoor air assessment in DGNB for Hotels and LEED for Hospitality

Although the categorization and criteria catalogue of the two assessment methods are radically different and different sustainability topics are allocated under different categories with different weightings, but the criteria related to indoor air quality in both two systems are mandatory and without the fulfilment of the minimum requirements of these criteria the building could not be certified as shown in Fig.2 and Fig. 3. In addition there are credit points that could be achieved. In DGNB the selection of building materials to avoid or reduce the indoor air pollution was separated from Indoor Hygiene in Socio-cultural and Functional Quality and dealt with in the Risk to Local Environment in the Ecological Quality and it is mandatory, meanwhile all the criteria related to the indoor air pollution are dealt with in only one category which is the Indoor Environmental Quality and the selection of Low-emitting materials isn't mandatory but 3 possible point could be achieved. Moreover, indoor air testing is mandatory in the DGNB while it is optional in the LEED and 2 possible points could be achieved as shown in Table 1.

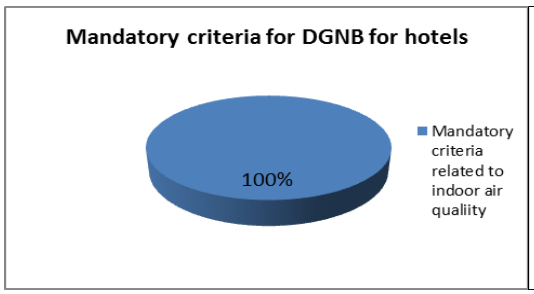

Fig. 2: Mandatory criteria related to indoor air quality in DGNB for hotels represent 100% of the total number of mandatory

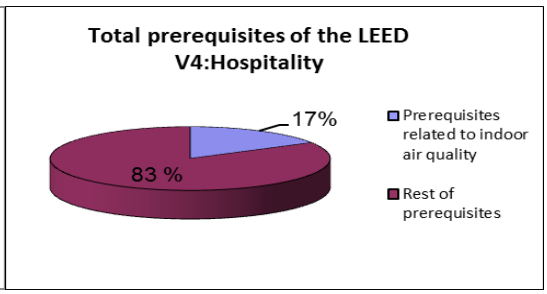

Fig. 3: Mandatory criteria related to indoor air quality in LEED V4: Hospitality represent 17% of the total number of mandatory criteria

TABLE I: Comparison between Indoor Air Quality Assessment in the Two Pioneer Rating Systems for Hospitality

Comparison Between Indoor Air Quality Assessment in The Two Pioneer Rating Systems for Hospitality			
DGNB for Hotels	Weighing	LEED V4 BD+C: Hospitality	Weighing
Ecological Quality	200 points out of 990	Indoor Environmental Quality (EQ)	16 points out of 110
Risk To Local Environment	Required In addition 10-30 possible credit points	Minimum indoor air quality performance • Ventilation • Monitoring	Required In addition 8 possible points
Socio-cultural and Functional Quality	280 points out of 990	Environmental Tobacco Smoke Control	Required
Indoor Hygiene	Required In addition 10-30 possible credit points	Enhanced indoor air quality strategies	2 points
		Low-emitting materials	3 points
		Construction indoor air quality management plan	1 points
		Indoor air quality assessment • Option 1. Flush-out (1 point) • Option 2. Air testing (2 points)	2 points
Total	Mandatory 60 possible points Approx. 6 %	Total	Mandatory 8 possible points Approx. 7 %

4. Results

Based on the analytical comparison between the two rating systems, the GPRS team with the technical assistant of DGNB experts developed GPRS-H to go with Egypt-specific legal, cultural and technical aspects. The basic approach for maintaining healthy indoor air is first to avoid the emission of pollutants as far as possible, and then to use ventilation to expel and dilute those pollutants which have been emitted. After that applying indoor air assessment to ensure a good and healthy indoor air quality as shown in Fig.4 . As a result a checklist was developed for indoor air quality in hotels. All the categories, indicators and possible credits are explained in the checklist shown in Fig 5-1 & Fig 5-2. But more explanation for some issues will be discussed below the checklist.

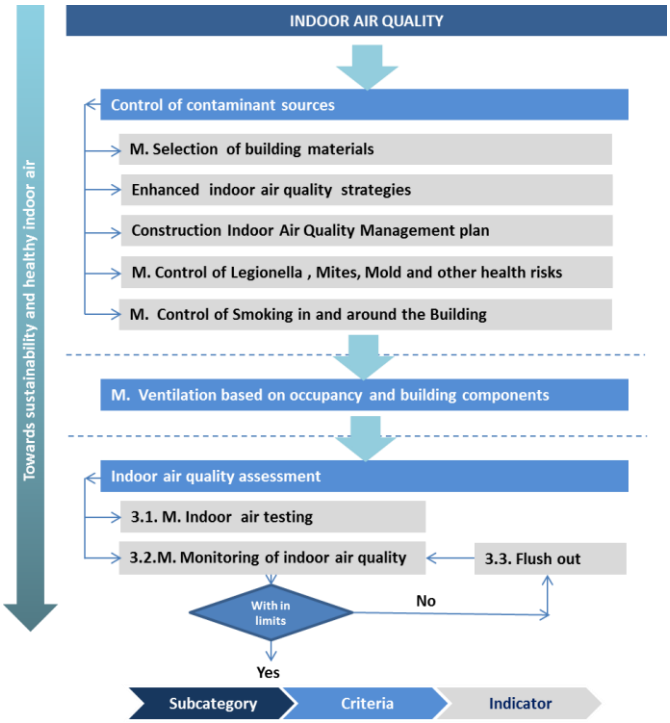

Fig.4: The criteria and indicators developed for indoor air quality

Hotels /Resorts -GPRS Criteria for Indoor Air Quality								
HOTEL NAME:					M	Points Available	Score	Reason why
4.1. Control of contaminant sources	4.1.1. M. Selection of building materials	Measurement of emissions after 28 days according tothe Germany's Committee for the health - Related Evaluation of Building Products (AgBB) Testing and Evaluation Scheme (2010)	1	A product satisfies the criteria, if the TVOC 28 value is < 1.0 mg/m³. Products with a TVOC value higher than that are rejected.	M	no credit points awarded		
			2	A product satisfies the criteria if the sum of the SVOC concentrations in the chamber air does not exceed 0.1 mg/m³.				
			3	No carcinogen of categories 1 or 2 [Directive 67/548/EEC] may exceed the value of 0.001 mg/m³				
			4	VOC assessable via LCI :For a large number of VOC found in indoor air a list of so-called LCI values (Lowest Concentration of Interest)(AgBB - Evaluation procedure for VOC emissions from building products; March 2008) . Listed substances whose concentrations in the test chamber exceed 5 g/m³ are evaluated based on LCI. They are quantified using their individual calibration factors.				
			5	VOC not assessable via LCI In order to avoid the risk of a positive evaluation of a product which emits larger quantities of non assessable VOC, a limit is set for those VOC which cannot be identified or do not have an LCI value. This limit equals 10 % of the permitted TVOC value, for the sum of such substances. A product meets the criteria when the sum of such VOC determined at concentrations >0.005 mg/m3 does not exceed 0.1 mg/m³. Higher concentrations result in rejection.				
	4.1.2. Enhanced indoor air quality strategies	Removal of contaminant sources and control of contaminant sources by achieving criterion 4.1.1. M.				1 credit point		
		Healthy Ventilation Delivery: o Undertake and document an observational survey of local air quality according to sections 4.2 and 4.3 of ASHRAE 62.1.2007. o For air-conditioned and mixed-mode areas: the building's air intakes and exhausts are over 10m apart to minimize recirculation and intakes are over 20m from sources of external pollution. o For naturally-ventilated areas: openable windows/ventilators are over 10m from sources of external pollution.						
	4.1.3. Construct-ion Indoor Air Quality Management plan	Demonstrate the development and implementation of a comprehensive Construction IAQ Management Plan. At a minimum the plan must address the following: • Protect absorptive materials stored on-site and installed from moisture damage. • Do not operate permanently installed air-handling equipment during construction unless filtration media with a minimum efficiency reporting value (MERV) of 8, as determined by ASHRAE 52.2–2007, with equivalent filtration media class of F5 or higher, Particulate Air Filters for General Ventilation, Determination of the Filtration Performance, are installed at each return air grille and return or transfer duct inlet opening such that there is no bypass around the filtration media. • Immediately before occupancy, replace all filtration media with the final design filtration media. • Prohibit the use of tobacco products inside the building and within 8 meters of the building entrance during construction.				2 Credit points for developing a construction IAQ plan in addition of 2 Credit points for implementing the construction IAQ plan		
	4.1.4.M. Control of Legionella , Mites, Mold and other health risks	Control of Legionella and other health risks	Demonstrate that a Legionella Management Plan exists for all relevant water based systems. The Legionella Management Plan must be set out in accordance with Part 1 of 'Legionnaire's Disease- The Control of Legionella Bacteria in Water Systems', Approved Code of Practice and Guidance (L8), 3rd Edition 2000, UK Health and Safety Executive. • The Legionella Management Plan must include: o Risk Identification and Risk Assessment; o Risk Management Plan for management responsibilities, training & competence; o An Exposure Risk Prevention or Control Plan; o Record Keeping Plan; and Responsibility Plan for manufacturers, importers, suppliers & installers. • Follow the requirements and guidance in Approved Code of Practice and Guidance (L8), 3rd Edition 2000, UK Health and Safety Executive (or other approved) and integrate this plan into the Operations & Maintenance Manual (OMM).		M	no credit points awarded		
		Control of Mites, Mold	1	Select interior materials to restrict the growth of mold and mites, and to facilitate cleaning and maintenance.	M	Acccording to % of the area of floors and external walls has been designed to restrict the growth of mites and mold, or to facilitate cleaning and maintenance *3 credit points at least 80% *2 credit points at least 65%, but less than 80% *1 credit points at least 50%, but less than 65%		
			2	For the sake of hygiene it is desirable to use wood or plastic floor coverings or tiles wherever possible, as they allow complete removal of dust and waste through cleaning.				
			3	If carpets are used, they should be short pile, allowing appropriate cleaning and maintenance to remove dead mites and dust.				
			4	Tiles that can be removed for cleaning are better than wall-to-wall carpets.				
			5	Materials that resist mites and mold are preferable to materials that rely on chemical treatment.				
			6	Measures must also be taken against condensation, which is the root cause of mold.				
	Max. Total points of Control of Legionella, Mites, Mold and other health risks : 3 Credit points							
	4.1.5.M. Control of Smoking in and around the Building	1.	Design smoking areas located at least 7.5 meters from all entries, outdoor air intakes, and operable windows.		M	no credit points awarded		
		2.	Locate any dedicated external smoking areas away from public or high use pedestrian thoroughfares and install suitable facilities for collecting ash and cigarette ends.					
		3.	Provide specifications for weather-stripping installation for doors and windows.					
		4.	Provide specifications for weather-stripping installation for doors and windows.					
Max.total								
4.2.M. Ventilation based on occupancy and building components	1	High degree of expectation in accordance to EN 15251	Air flow per person 10 l/s/pers		M	5 Credit points		
			0,5 ACH per m2 for Extra- low- emission hotels					
			1 ACH per m2 for Low- emission-buildings					
			2,0 ACH per m2 for Hotels with high emissions					
	2	Normal degree of expectation	Air flow per person 7 l/s/pers			2.5 Credit points		
			0,35 ACH per m2 for extra- low- emission hotels					
			0,7 ACH per m2 for Low- emission-buildings					
			1,4 ACH per m2 for Hotels with high emissions					
	3	Acceptable, moderate degree of expectation	Air flow per person 4 l/s/pers			Hotel will not be certified		
			0,2 ACH per m2 for extra- low- emission hotels					
			0,4 ACH per m2 for Low- emission-buildings					
			0,8 ACH per m2 for Hotels with high emissions					
Max. total points of ventilation based on occupancy and building components : 5 Credit points								

Fig.5-1: The developed checklist for indoor air quality in sustainable hotels in Egypt

4.3. Indoor air quality assessment	4.3.1. M. Indoor air testing	4.3.1.1.M. Testing of volatile organic compounds and formaldehyde	1	TVOC [µg/m³]concentrations for all of the tested rooms < 500	M	5 Credit points		
				Formaldehyde [µg/m³]concentrations for all of the tested rooms < 60				
			2	TVOC [µg/m³]concentrations for all of the tested rooms < 1000		2.5 Credit points		
				Formaldehyde [µg/m³]concentrations for all of the tested rooms < 60				
			3	TVOC [µg/m³]concentrations for all of the tested rooms < 3000		1 Credit points		
				Formaldehyde [µg/m³]concentrations for all of the tested rooms < 120				
			4	TVOC [µg/m³]concentrations for all of the tested rooms > 3000		Hotel with such a high concentration will not be certified		
				Formaldehyde [µg/m³]concentrations for all of the tested rooms > 120				
		4.3.1.2.M. Testing of other indoor air pollutants	1	Particulates PM10 do not exceed 50 micrograms per cubic meter according to ISO 7708	M	no credit points awarded		
			2	Maximum concentration of ozone is 0.075 ppm according to ISO 13964				
			3	Maximum concentration of carbon monoxide (CO)is 9 ppm; no more than 2 ppm above outdoor levels according to ISO 4224				
	Max. total points : 5 Credit points							
	4.3.2.M. Monitoring of indoor air quality	• For mechanically ventilated spaces (and for mixed-mode systems when the mechanical ventilation is activated), monitor outdoor air intake flow as follows: o For variable air volume systems, provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow. This device must measure the minimum outdoor air intake flow with an accuracy of +/–10% of the design minimum outdoor airflow rate, as defined by the ventilation requirements above. o An alarm must indicate when the outdoor airflow value varies by 15% or more from the outdoor airflow setpoint. o For constant-volume systems, balance outdoor airflow to the design minimum outdoor airflow rate defined by ASHRAE Standard 62.1–2010 (with errata), or higher. Install a current transducer on the supply fan, an airflow switch, or similar monitoring device.			M	no credit points awarded		
		• For naturally ventilated spaces (and for mixed-mode systems when the mechanical ventilation is inactivated), comply with at least one of the following strategies. o Provide a direct exhaust airflow measurement device capable of measuring the exhaust airflow. This device must measure the exhaust airflow with an accuracy of +/–10% of the design minimum exhaust airflow rate. An alarm must indicate when airflow values vary by 15% or more from the exhaust airflow setpoint. o Provide automatic indication devices on all natural ventilation openings intended to meet the minimum opening requirements An alarm must indicate when any one of the openings is closed during occupied hours o Monitor carbon dioxide (CO2) concentrations within each thermal zone. CO2 monitors must be between 900 and 1800 millimeters above the floor and within the thermal zone. CO2 monitors must have an audible or visual indicator or alert the building automation system if the sensed CO2 concentration exceeds the setpoint by more than 10%. o Calculate appropriate CO2 setpoints using the methods in ASHRAE 62.1–2010, Appendix C. o Undertake dynamic simulation modeling (DSM) for the natural ventilation period of operation, to demonstrate the effectiveness of the operable window open areas in terms of thermal comfort, internal CO2 levels and ventilation rates.					
		• Monitoring Car Park Air Quality Demonstrate that the ventilation design meets or exceeds requirements for pollutant concentrations in car parks This will be achieved via continuous measurement of the following pollutants: • Maximum concentration of Carbon Monoxide (CO) 100 mg / m3 in 15 minutes • Maximum concentration of Nitrogen Dioxide (NO2) 200 g/m3 in 1 hour • Maximum concentration of Particular Matter PM10 50 µg/m3 in 24 hours				1 credit point and if the project does not contain any enclosed car parks (75% enclosure), the credit is automatically awarded		
	4.3.3. Flush out	Before occupancy Install new filtration media and perform a building flush-out by supplying a total air volume of 4 267 140 liters of outdoor air per square meter of gross floor area while maintaining an internal temperature of at least 15°C and no higher than 27°C and relative humidity no higher than 60%.				1 Credit points		
		During occupancy If occupancy is desired before the flush-out is completed, the space may be occupied only after delivery of a minimum of 1 066 260 liters of outdoor air per square meter of gross floor area while maintaining an internal temperature of at least 15°C and no higher than 27°C and relative humidity no higher than 60%. Once the space is occupied, it must be ventilated at a minimum rate of 1.5 liters per second per square meter of outdoor air or the design minimum outdoor air rate determined in 4.2.M. Ventilation based on occupancy and building components, whichever is greater. During each day of the flush-out period, ventilation must begin at least three hours before occupancy and continue during occupancy These conditions must be maintained until a total of 4 270 liters of outdoor air per square meter has been delivered to the space.						
Max. total points 0f indoor air quality assessment : 7 Credit points								
Maximum total points for indoor air quality: 20 Credit points								

Fig.5-2: The developed checklist for indoor air quality in sustainable hotels in Egypt

Important remarks for some important issues:

- **Measurement and evaluation of VOC emissions from building products**

As still there is no eco-label for building materials now in Egypt, all the materials should be tested for the evaluation of emission of VOC in accordance with the Germany's Committee for the health - Related Evaluation of Building Products (AgBB) Testing and Evaluation Scheme [2] recommended by both the DGNB and the LEED systems. A building product which fulfils the requirements set out in (AgBB) Testing is suitable for use in enclosed building spaces. If the building material is imported and certified by any international labels in the

field of construction materials that refer to emissions, e.g, the "Blue Angel", "EMICODE" in Germany or "Greenquard" in the USA, this material could not be tested but evidence should be submitted [3].

- **Listing of the component surfaces**

A product-specific list of at least 80 % of the surfaces of walls, floors, ceilings or roofs to be documented. Surfaces used for certain purposes can be excluded from consideration. In such a case, documentation must state that the excluded surfaces do not make up more than 20 % of the total surface area in that area of use e.g. elevators.

- **Ventilation based on occupancy and building components**

According to DIN 15251, the ventilation rate for non-residential buildings is designed based on building and occupancy components as shown in the checklist.

- **Testing of volatile organic compounds and formaldehyde**

As there is no possibility for estimation of indoor air concentration in relation to the emission mass flow of installed components, after completion of the building it is necessary to check the emission concentration of both volatile organic compounds and formaldehyde. The measured concentrations are the base for assessment. According to a World Health Organization (WHO) a concentration of TVOC (Total Volatile Organic Compounds) more than 3000µg/m³ [4] or more than 120µg/m³ for formaldehyde [5] will be classified as alarming. That's the reason why buildings with such a high concentration will not be certified. Where levels are found to exceed these limits, the project team will take corrective action in accordance with the IAQ plan, to reduce the TVOC and formaldehyde levels to within the above limits. At the latest, after four weeks from the building completion, conduct baseline IAQ testing using protocols. Current versions of ISO methods could be used. Laboratories that conduct the tests for chemical analysis of formaldehyde and volatile organic compounds must be accredited under ISO/IEC 17025 for the test methods they use. The minimum numbers of rooms which have to inspect are specified in the following table.

TABLE II: Number of rooms to be tested

Rooms in the building	Type of room standard	Number of rooms to be tested
≤ 100	Essentially the same types of room standards	2
	Room standards present in more than 10 % of all of the rooms in the building	1 per type
>100	Essentially the same types of room standards	3
	Room standards types present in more than 10% of all of the rooms in the building	2 per type

5. Future Implementation

As this is just a start for developing a sustainable rating system for hospitality in Egypt, this system should continually be developed and monitored. In this sector, experts from different sectors should work together across disciplines to ensure the quality of the system. Besides, applying this rating system on a pilot project would be very useful for making the research more valid.

6. Conclusions

For enhancing indoor air quality, further work for this matter would be formed around this question: How could we set a data base for healthy building materials in Egypt? Housing and Building National Research Center (HBRC) has a big role in developing legal mechanisms, completing and improving standards, this role can be summarized as follows:

- Understanding the current condition and the need for establishing a national association for the control of emissions from building materials. All manufactures of indoor installation products, adhesives, construction materials or supplier of associated raw materials anywhere in Egypt can become members of the association. And establishing a Technical Advisory Board whose main purpose will be to promote consumer, occupational and environmental protection in the field of chemical construction materials and adhesives. The first and most important step was to provide the market with suitable means to obtain an

impartial review of, and differentiation between the wealth of installation materials, adhesives and construction materials in respect of their VOC emission characteristics. In order to do so:

  - Test methods should be defined. Product tests may only be conducted by a test laboratory or institute accredited according to ISO 17025. The established association can provide names of accredited test institutes on request.
  - Developing a classification criteria for building materials for distinguishing product groups with certain common hazardous features.

- Certifying tested and classified building materials, in order that all building materials available in the national market should be CERTIFIED.
- Creating or completing building materials databases, establishing Material Directive for all existing active substances and systematic review will be fed .
- Co-operation with Federation of Egyptian Industries and establishing local organizations and governmental or non-governmental departments for testing and certifying building materials following a procedure which must be developed and defined in cooperation with recognized testing institutions.

7. Acknowledgments

The Egyptian Green Pyramid Rating System for Hotels has been made possible only through the efforts of the team members, and the technical support of GIZ Egypt (German Society for International Cooperation), JCEE (Egyptian German Joint Committee on Renewable Energy, Energy Efficiency and Environmental Protection) and Iproplan Planners Co. Ltd (Consulting Engineers & Architects Company) under the HBRC (Housing and Building National Research Center in Cairo) umbrella.
I extend my deepest gratitude to all my team members who participated in the development of this rating system, for their tireless efforts and constant support of this mission.

8. References

[1] U.S. Green Building Council (2013). LEED BD+C: Hospitality-Indoor Environmental Quality *[Online]*. Available: http://www.usgbc.org/credits/hospitality---new-construction/v4/indoor-environmental-quality , accessed 15.12.2014.

[2] [2] AgBB (Committee for Health – related Evaluation of Building Products) (June 2012). Evaluation procedure for VOC emissions from building products *[Online]*. Available: http://www.umweltbundesamt.de/sites/default/files/medien/355/dokumente/agbb_evaluation_scheme_2012_0.pdf , accessed 16.4.2012.

[3] Eurofins Product Testing A/S (2013) . Comparison: EMICODE EC1PLUS, EMICODE EC1, Blue Angel RAL UZ 113, AgBB, CDPH Section 1350*[Online]*. Available: http://www.emicode.com/fileadmin/redaktion/pdf/emicode_-_blue_angel_-_section_01350_-_en.pdf , accessed 4.12.2014.

[4] Occupational Health & Safety (2013), Building Materials Can Be a Major Source of Indoor Air Pollution*[Online]*. Available:https://ohsonline.com/Articles/2013/09/01/Building-Materials-Can-Be-a-Major-Source-of-Indoor-Air-Pollution.aspx, accessed 1.12.2014.

[5] World Health Organization, *WHO guidelines for indoor air quality: selected pollutants*. Copenhagen, Denmark, 2010, pp. 141.