Culturally Accepted Green Architecture Toolbox

Pre-design helping tool and rating system for new built environment in Egypt

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Abstract: This paper describes and analyses the process of developing computer software to incorporate both green architecture design strategies and their cultural indicators in one easy tool to help a designer to match his / her design with green architectural principles in the pre-design stage. The three resources of architectural identity in Egyptian, current and past green building practices with the up to date foreign knowledge of green architecture were combined in one toolbox with their building cultural indicators in Egypt. Using the toolbox in primary design stage helps the designer by providing more information about each green design strategy, how to use it effectively. Finally, the toolbox provides indicators about how much the whole project will be accepted in Egyptian society and to what extend it applies green architectural principles. For verification reason, the toolbox was tested with two groups of students in Egypt and The Netherlands as well as professional architects from both countries.

1. INTRODUCTION

There is wide knowledge and experience on green architecture principles, but the choice of other priorities or values than environment and climate in the building construction affects the degree of adaptation to climatic comfort and environmental sensitivity. There are many examples around the world of how people do not respond primarily to climate, environment, or economic factors but to their culture (Rapoport, 1986). Indeed, cultural values form a great gap between theoretical principles and the implementation processes of green architecture.

Jos P. van Leeuwen and Harry J.P. Timmermans (eds.), Innovations in Design & Decision Support Systems in Architecture and Urban Planning, 341-356.

This research theory focuses on the identification and incorporation of cultural aspects of current and past green building practices in Egypt with the current foreign knowledge of green architecture. Avoiding cultural obstacles, the green design strategies generated from previous three resources of architectural identity of Egyptian community are culturally tested by non professionals in Egypt thus each green design strategy is labeled with a building cultural indicator which means the acceptance level. User oriented technology is used for verification reason where two separated student design workshops were organized at the Technical University of Eindhoven, The Netherlands and Alexandria University in Egypt. The final version of the toolbox will be tested again by professional architects from The Netherlands and Egypt.

This research product is an easy primary design toolbox to be used by the designer in order to incorporate green architecture principles in new urban settlements generally in hot arid zones and particularly in Egypt's vast desert. Delphi Computer language is used to produce a software version of the toolbox.

Since this paper presents the final results of a PhD research, it will briefly describe how the contents of the toolbox (green design strategies) are collected and how they are culturally tested by questioning non-professionals in Egypt then the procedure of utilizing the toolbox through the student's design workshops for verification reasons and finally the programming process of the final software.

2. DATA COLLECTION FOR THE TOOLBOX

2.1 Rating Systems

More efforts have been done to benchmark the built environment from a green architecture point of view. Thus a large number of systems have been developed to analyse building sites and buildings. Rating systems are organized in form of checklist which gives credit points to existing buildings.

The production of environmental programmes and building codes is, of course, not entirely a matter of science. Rather, it is highly social and contentious processes in which some interests are suppressed and others are reinforced. Commercial construction certification schemes like LEED and BREEAM are just a few examples. (Smith, 2005)

This research studies both the contents and the format of those rating systems. Studying the content helped to understand different green architectural design strategies concerning housing in hot arid regions around

the world. Studying the format helped to understand the order and mechanism of such rating systems in order to develop another tool for Egypt. Most of the existing rating systems have been investigated. The following chapter will briefly survey the characteristics of some of them.

2.1.1 Existing Rating Systems

2.1.1.1 EcoHomes

EcoHomes is the homes version of BREEAM (Environmental Assessment Method of Building research establishment). It covers all standard housing developments in England, Scotland, Wales and Northern Ireland. It provides an authoritative rating for new, converted or renovated homes, for both houses and apartments. EcoHomes balances environmental performance with the need for a high quality of life and a safe and healthy internal environment.

The issues assessed are grouped into seven categories: ecology and land use, water, energy, pollution, materials, health and well-being and transport. A project judged by EcoHomes can achieve 'pass', 'good', 'very good' or 'excellent' rating based on the number of points achieved in these seven environmental categories (EcoHomes, 2003).

2.1.1.2 LEED rating system

The Leadership in Energy and Environmental Design (LEED™) Green Building Rating System initiated by the U.S. Green Building Council's provides a national standard for developing high-performance, sustainable buildings.

Based on well-founded scientific standards, LEED emphasizes state of the art strategies for sustainable site development, water savings, energy efficiency, materials selection, indoor environmental quality and innovation. A project judged by LEED can achieve 'Certified', 'Silver', 'Gold', or 'Platinum' rating based on the number of points achieved in these six environmental categories.

Members of the U.S. Green Building Council (USGBC), representing all segments of the building industry, developed LEED by consensus and continue to contribute to its evolution. (The U.S. Green Building Council, 2002)

2.1.1.3 Built Green

Built Green is an environmentally-friendly, non-profit, residential building program of the Master Builders Association of King and Snohomish Counties, developed in partnership with King County, Snohomish County, and other agencies in Washington State.

Built Green provides a framework for assessing building performance and meeting sustainability goals in the areas of site and water, energy efficiency, materials selection, indoor environmental quality, homeowner education and innovation. A building project earns points in each of these six environmental areas to achieve a Built Green™ one, two or three star rating (Washington State and Home Builders Association of Metro Denver, 2003).

2.1.2 Analysis of Existing Rating Systems and Guides

1 - Existing rating systems need other programs, codes and regulations to assess building performance to be an evidence of rating the building from the green architecture point of view. Other codes such as; International Energy Conservation Code 2000 (IECC), International Residential Code (IRC), E-Star Colorado, American Lung Association Health House Standards and programs such as; RESCheck software and more.

2 - Existing rating systems cover only green buildings design aspects. They don't address green urban design aspects. For example they concern about the close distance of building to the mass transportation and provision of bicycle storage but they don't address the design of the city to be walkable, cycle able and all houses are within short distances to mass transportation.

3 - Existing rating systems do not differentiate between design features and design targets. They mix them in the checklist and each design target or design feature achieve some credit points. For example, LEED does not differentiate between certified wood as a design feature and rapidly renewable materials as a design target. Actually, it gives credit points for both. EcoHomes does not differentiate between provision of drying space and cycle storage as design features and improving the performance of the building envelope as a design target actually it gives credit points for all.

4 - The order of most existing rating systems does not meet the requirements needed to develop a culturally accepted pre-design tool (the research target) which covers all phases of the design process. The new tool needs to address the design features instead of the design targets to be easily culturally tested by non professional people.

5 - The weight balance for different categories of green architecture is culturally sensitive and varied depending on the country of production. For example, energy use gets 21% in EcoHomes and 25% in LEED and 42% in Built Green Colorado. Health gets 17% in EcoHomes and 22% in LEED and 13% in Built Green Colorado. The new toolbox for Egypt will give fixed point to each green design strategy and the cultural acceptance will give weight balance for each strategy.

6 - Some green design strategies (features) serve in different elements of natural environment. For example, using local materials serves in both

categories material efficiency and energy efficiency. Mass transportation serves in both energy and sitting. This confusion leads to differences in existing rating systems.

7 - The method of Built Green rating system is suitable for the new toolbox where it demonstrates the green architecture design strategies which covers whole live cycle of the buildings (design, construction, operation and demolish phases). The new toolbox will cover only the design phase but for both fields architecture and urban design.

8 - The green design strategies which cover all aspects of housing design and how they are linked to and promote some aspects of natural environment or human comfort will be used as one of the resources to develop the new toolbox.

2.1.3 Green Architecture Categories

From previous green architecture principles and rating systems 15 categories of green architecture are generated. Each category includes some theoretical green architecture design strategies.

Regarding the elements of natural environment (energy, water, materials, atmosphere, land fauna and flora in addition to human being), five main categories could be generated as the main green architecture categories from the previous 15 categories demonstrated by existing green architecture rating systems and checklists. Indeed, green architecture principles come to make a balance among the elements of the natural environment.

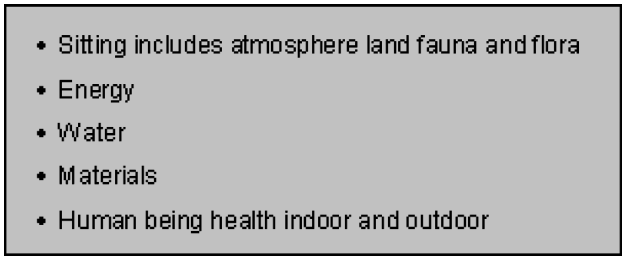

Figure 1. Main Categories of Green Architecture.

2.2 Projects Applying Green Architecture Principles

To understand practically the different green architectural design strategies concerning housing in hot arid regions, there are clear lessons to be learned by considering historical precedents and current examples around the world which claim applying green architecture principles.

2.2.1 Projects Examples

By demonstrating the following projects the research will address just the proven green design strategies for both architecture and urban design. Currently, the research is not going to judge the green design strategies from Egyptian building culture view. The only judgement will come later in chapter 4 by questioning non professional people in Egypt.

In the following examples, the green design strategies (features) will be arranged according to the design process phases instead of previous green architecture categories.

2.2.1.1 **Civano: Tucson's solar Village** (Corbett and Corbett, 2000)

The master plan for Civano Solar Village is distinctive by the following green design strategies:

- Compactness - High residential densities
- Mixed land use (integrates residential with shopping, workplace, school, and civic facilities)
- Using native, drought-tolerant plants
- Internal circulation system is designed to encourage both bicycle and pedestrian traffic
- The project has the latest fiber optic telecommunications
- Thermal mass technique is used for the walls
- Straw bales, wood frame, adobe, fly ash concrete and Rastra construction
- Insulated masonry block construction
- Solar photovoltaic panels
- Hot water systems located on roofs
- Dual plumping system
- Water harvesting

Figure 2. Straw bale construction.

2.2.1.2 Findhorn ECO Village

The master plan for ECO village Findhorn is distinctive by the following green design strategies:

- Shared facilities (laundry, kitchens, lounges) avoiding unnecessary duplication
- Use of passive solar features where possible through orientation and window layout
- Cellulose insulation (made from recycled paper)
- Non-toxic organic paints and wood preservatives throughout
- Boarding manufactured without the use of toxic glues or resins
- Locally grown and harvested timber from managed forests
- Local stone for skirting, patios and pathways
- Roofing with natural clay tiles

Figure 3. Roof garden house (Eco Village Findorn).

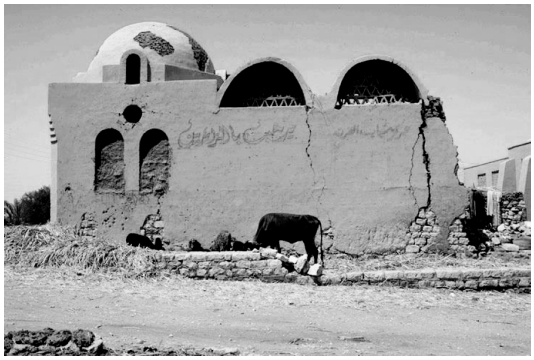

Figure 4. Dome and vaults in New Gourna village – Egypt.

2.2.1.3 New Gourna Village (West Luxor, Egypt) (Fathy, 1986)

The master plan for New Gourna village Findhorn is distinctive by the following green design strategies:

- Courtyard house
- Domes and Vaults
- Mud brick construction system
- Fountain
- Wind catcher (MALGAF)
- Wooden Screen with a lattice-grill work (MASHRABIYA)
- Clerestory

2.3 Field Survey

The field survey is to figure out the influence of building culture on architecture performance. It also contributes to give insight and outline a clear image of Egyptian building culture and to figure out the potentials of green architecture practices in. Finally, it aims to produce a building culture indicator for each green design strategy (to what extent each green design strategy is accepted in Egypt).

2.3.1 The Survey Procedures

2.3.1.1 Focused Issues of the Field Survey

The field survey addressed selected aspects of green architecture design strategies of the following main topics:

- Urban scale: land use, building density street design and transportation
- Building management: Ownership, Design and construction management
- Architectural scale: Construction system, Building materials and Passive climatic design features
- Building facilities and installations: Artificial lighting, Electric appliances, Potable water fixture and Energy supply
- Landscape: Vegetation, Water bodies

2.3.1.2 Sampling Frame and Method used for Data Analysis

Samples of the Egyptian inhabitants 'Non-professionals' will act as informants for the purpose of collecting data. One member of each household has been asked to fill out the questionnaire.

In order to outline a real building culture image for Egypt, it would be impractical to execute a detailed survey for all Egyptians; therefore a random stratified sampling method is used to get right samples where four different main areas were identified to participate, distinguished by both climatic and cultural characteristics. One city and one village are chosen to represent

each area. Both genders of different level of education and age were targeted by the survey. (Bernard, 1995)

The four regions are: (Hemdan, 1980) (CAPMAS, 2004)

- Lower Egypt (all delta region including Cairo and Alexandria cities)
- Desert (all oasis in western desert)
- Upper Egypt (all cities and village along The Nile River Valley)
- Nubia (Nubians who live around the aria of Lake Nassir from Aswan to Abu sembel cities)

Minimum of 50 surveys were distributed in each region for a minimum total of 200 distributed for each questionnaire. The response rat was 80% (160 respondents), which helped to conduct a statistical analysis.

An SPSS 12.0.1 database was created to record participant's individual answers and analysis participant's answer.

2.3.1.3 Field Survey Steps

The field survey started with the fact mission trip followed by two different questionnaires.

A trip of ten days around Egypt with the supervisor of the research has been done on December 2003 to get acquaint with the general building cultural phenomenon in Egypt.

A survey of four different regions in Egypt (questionnaire I) was carried out on January 2004 in order to figure out the potentials of green architecture practices in Egypt. Three questions were asked for both current and past building practice then the preference in the future. A fourth question was asked to know the reasons behind this preference.

After the detailed analysis of the first questionnaire's findings, the current and traditional green practices in Egypt both with world green experience were presented in questionnaire II which was carried out on June 2004.

2.3.2 Field Survey Findings

Some of current traditional building practices which were considered as green architecture design strategies were included in the toolbox and were labelled with building culture indicator (the level of acceptance).

All green architecture design strategies which were collected around the world and presented to non-professionals in Egypt were also included in the toolbox and labelled with building culture indicator as well.

The findings of the field survey, together with accumulated experiences of green architecture around the world were used to develop the culturally accepted green toolbox.

3. THE TOOLBOX AND VERIFICATION PROCESS

3.1 Text Version of the Toolbox

In the text version of the toolbox, a list of green architecture design strategies for hot arid region around the world are organized in two main groups urban design strategies and Architecture design strategies. Each main group is divided into seven sub-fields.

The seven fields are organised to follow the logic phases of the design process to help the designer to corporate the green design features in the project easily during the first design stages. Each item is technically described in details. The following is the order of the main sub-fields in each main group of the toolbox.

A. Urban	**B. Architecture**
A.1 Urban fabric	E.1 site selection
A.2 Land use	E.2 Form, zoning and orientation
A.3 Public Landscape	E.3 Building Envelop
A.4 Streets	E.4 Construction Systems
A.5 Open spaces	E.5 Building Materials partially used
A.6 Transportation and accessibility	E.6 Building facilities and installations
A.7 Infrastructure	E.7 Private Landscape

Figure 5. The seven main fields of design process for urban and architecture design.

The same list of green design strategies is attached to the first list which contains the same green design strategies but with acceptance level generally for whole Egypt as well as for the different four regions around Egypt. The acceptance level was presented by percentage where more than 50 % means accepted and less than 50% means unaccepted.

3.2 Student's Design Workshops

The student's design workshops have been one of the elements of the research methodology that has been applied for the verification of the usability of the toolbox. The student's design workshops, presents the analytical comparison of the utilization of the developed culturally accepted green toolbox by the students during the two workshops in the Netherlands and Egypt. It also presents the critical feedback of the two groups of students about the toolbox. The findings of the two workshops, together with student's critical feedback were used to refine the toolbox.

3.2.1 The Workshop's Process

The main goal of the workshops was to test the developed culturally accepted green toolbox (text version) by utilizing it as a primary design toolbox to design a sustainable prototype design for the new region of Toshka in the southwest desert of Egypt, which has to comply with both green architecture principles and Egyptian building culture. As user oriented technology, the students have evaluated the green toolbox afterwards.

A workshop with third year students from different departments (Building Technology, Architecture, Urban Design and Technology Management) – Faculty of Architecture, Building and Planning at the Technical University of Eindhoven in the Netherlands was carried out on September 2004. The second workshop was carried out with third year architectural students in Alexandria University, Egypt on February 2005. The toolbox was presented to the students as a print out text version.

3.2.2 Toolbox Refinements

Regarding the findings of the two workshops, a list of refinements has been generated by student to improve the toolbox.

Refinement 1 some groups in both workshops did not choose from listed items within green toolbox but they add new items for some categories of design phases. The toolbox needs an easy technique to help the user add new items with his responsibility for greenness and cultural acceptance. This technique (adding new items if any) improves innovation and creativity of the user.

Refinement 2 both groups of students misunderstand the use of different items within the toolbox where they use the items that could not be used with each other. The toolbox needs some constraints to be added to notify the user with such conflicted items.

Refinement 3 changing the method of showing acceptance level for green design strategies from percentages to level of acceptance is recommended and very readable for architects and urban designers for example; strongly accept, accept and somewhat accept.

Refinement 4 showing total culture indicator and green certificate for the whole project is very important to help the designer to figure out to what extend the project has achieved green points and to what extend it will be culturally accepted.

Refinement 5 in addition to technical details of each green design strategy, more information is needed to be added to the toolbox explaining why such design strategies are green and culturally accepted. Other information like preconditions for such design strategies to achieve high

level of greenness also is needed. Relevant references like books, project examples and web site links are very important.

Refinement 6 considering that both groups of student do not follow specific sequence of design process, the toolbox has to be designed with free movement among its chapters.

Refinement 7 since not all items in the toolbox have the same weight in the design process, different green values (points) have to be given to each green design strategy in the toolbox.

Refinement 8 since most features of the toolbox are used to some extend, so a gradation should be included at every feature (low, average, high) or to be branched into more detailed items.

Refinement 9 A software version of the toolbox must be designed in order to contain all previous refinements. The software also must be flexible to accept addition of new green architecture design strategies in the future.

3.3 Professionals Test

After the refinement process of the toolbox according to the student's feedback a final version for the toolbox was prepared and a final verification is planed with some professional architects from Egypt and Netherlands to test the final version of the toolbox.

4. PROGRAMMING PROCESS

4.1 Delphi Computer Language (Cantu, 2003)

Green Architecture Design strategies; GADS Toolbox is not an interface for an ordinary database. It consists mainly of irregular structures, especially the constraints and the counting of the Green points and Culture indicator makes it very difficult to make such a design tool (stable and fast) in an ordinary database program. Delphi is chosen but also Visual Basic or C++ could have been chosen to develop the calculations routines (core) of which the majority are programmed as a library file (dll). This means that most windows applications (presentation) can read such files. Even Microsoft Excel and Microsoft Access can use the dll's functions without problems.

Actually the program was designed as follows:

1. input files (in txt format for simplicity)
2. core (calculations and constraint check)
3. presentation (screen and user interaction)

Therefore with minor changes, the GADS Toolbox software can be translated or converted to a different programming environment. The

program is stable and can be independently extended easily on all three levels. This is due to the fact that all three levels are independent of each other but interacting in a well defined way.

The Delphi solution has been chosen, mainly because the final user does not need to possess or buy Excel or Access because the GADS Toolbox is an independent program. Consequently, updating, maintaining and protection of the program is rather easy now.

4.2 Green Architecture Design Strategies (GADS)

4.2.1 Definition of Toolbox Software

GADS Toolbox is a primary design tool. It is a collection of green architecture design strategies organised in good order to be used by architects and urban designers with different concepts among three levels.

Firstly, it could be used for Toshka region Southwest desert of Egypt with average building culture indicator of different regions of Egypt. Secondly, it could be used particularly in different four regions around Egypt with building culture indicator for each region. Thirdly, it could be used generally for Hot Arid zone around the world as green design strategies without any culture indicator.

GADS toolbox provides green certificates for achieving greenness in the design as well as levels of acceptance indicator in Egypt for whole project during the primary design phase.

4.2.2 The Toolbox Software Main Features

1 - Through out GADS Toolbox, architects and urban designers can choose appropriate items for their design from a pool of green design strategies and print them out in two different forms; one with the titles of selected green design strategies and another with the titles in addition to their technical description.

2 - There are seven main fields in both branches of the Toolbox – urban and architecture design. Each main item contains more detailed items. The designer can start from any field he would like.

3 - Once the item is clicked, the information window at the bottom of the screen containing more technical information for each green design strategy will appear. A separate box shows some photos for each detailed item.

4 - There are two radio buttons at the upper right corner of the screen for the choosing process; ‘Select’ and ‘Not initialized’ buttons. ‘Not initialized’ button will be the default. The designer must click the select radio button if he decides to use specific item in the project. It is also possible to unselect

the item by clicking the 'Not initialized' button whenever the designer wants even if he moved to another sub-field.

5 - Some of the green design strategies cannot be used in parallel or will add just one green point for both items so the program will notify the designer about these constraints. Still he is able to select the item after acceptance of the notification.

6 - Each design strategy is labelled with building cultural indicator in Egyptian society and accumulated points are collected when selecting every item in order to be calculated for whole project. The total cultural indicator for whole project will be shown during the navigation through the program and reported at the print out form. There are six levels of acceptance which can be achieved varying from 'strongly accepted' to 'strongly un-accepted'.

7 - Some green design strategies have no cultural indicator. Either because they were not tested or not relevant to culture practice – people never considered them.

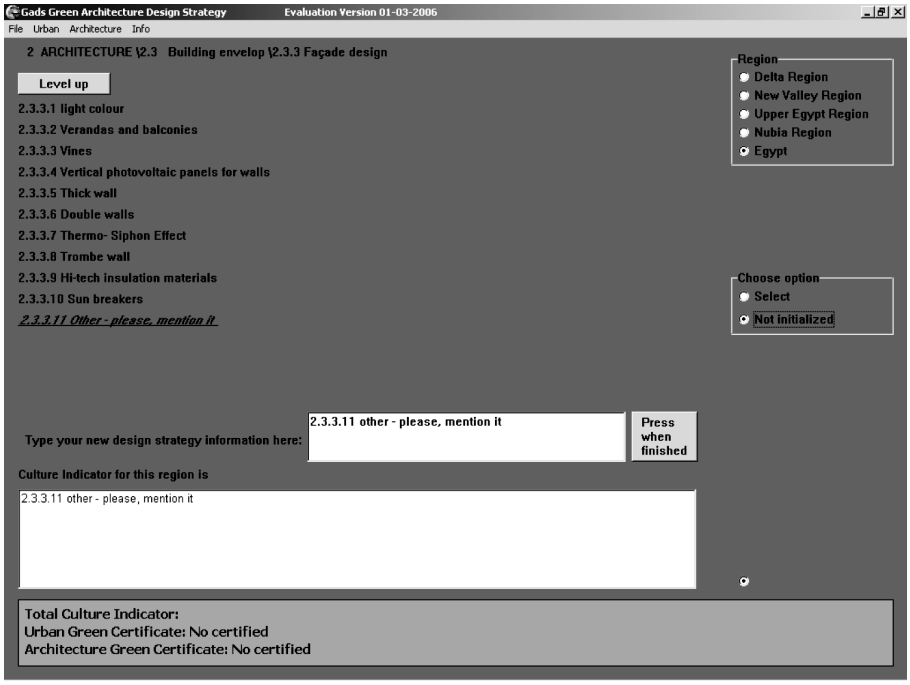

Figure 6. GADS interface.

8 - Each design strategy is labelled with scored point for green architecture and accumulated points are collected when selecting every item. Green certificate for whole project in both main branches Urban and architecture will be shown during the navigation through the program and

reported at print out form. Each design has to achieve specific amount of points to score different level of green certificate which starts from not certified, bronze, silver, golden and platinum.

9 - Instead of selecting from the listed green design strategies, the designer can choose to add his own design strategy at the end of each field and write down a brief description of such design strategy in the information box, which will appear in the print out form without building cultural indicator or green point (on his responsibility).

10 - The software is designed to read plain text files which easily could be altered or redefined. Separated text files are dedicated to different kind of data for example; toolbox text file which contains all green design strategies and their technical description other contains building cultural indicators and other contains constraints.

5. CONCLUSIONS

1 - With this culturally accepted green toolbox GADS, a minimum level of applying green architecture principles in Egypt is insured. In order to achieve high level of applying green architecture in Egypt the building culture of Egyptian has to be changed through:

- Teaching upcoming architects (the university students) using the GADS toolbox;
- Apply GADS with Governmental, regional and local authorities building;
- Both pioneer architects and owners to utilize GADS toolbox.

2 - Applying sustainable settlements in the new region of Toshka south west desert of Egypt is possible by using the developed software program GADS toolbox.

3 - By testing the three resources of Architecture identity of Egyptian community (current and past green building practices in Egypt with the current foreign knowledge of green architecture) through questioning non-professionals, Egyptian building culture has great potentials to implement green architecture principles in Egypt.

4 - One of the effective approaches to apply green architecture in Egypt is the cost of green architecture practices. The more green architecture is cheaper the more green architecture will be applied. More concern is needed about affordable green architecture practices such as existing mud brick house as well as the current situation of less ownership of private car.

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