An Analysis of two Sustainable projects in the light of the LEED-NC and LEED-ND rating systems

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Abstract: The methodology used in this paper consists in studying how the 5 environmental categories of the LEED New Constructions and Major Renovation plus the 3 categories of the LEED Neighbourhood Development apply to the architectural and urban design strategies of two projects: Masdar City and "Forwarding Dallas". We chose two very different but at the same time similar projects which claim to be environmentally conscious. On one end, there is the self-intituled "world's first carbon-neutral city", Masdar, designed by Foster + Partners and one of the largest and most ambitious developments of its kind. On the opposite end, and in a significantly smaller scale, there is the "Re-Vision Dallas" competition winner project, "Forwarding Dallas", designed by a collaboration of two Portuguese architecture practices: DATA + MOOV. This competition promoted the idea of transforming a vacant inner-city block in Dallas into a carbon-neutral neighbourhood, creating, for that purpose, a prototype for an innovative, sustainable urban community.

This paper strives to highlight, through the comparative analysis of these two projects, how the desire to meet high standards of sustainability not only affects the practice of architecture and urban design, but might also generate a particular architectural language with identifiable physical characteristics.

Keywords: *Carbon-Neutral, Masdar City, Forwarding Dallas, LEED, Renewable Energy*

1. Introduction

This paper presents part of a research developed by a research unit, named "*+E-CO2*", or "*More Energy, Less Carbon"*, based in Lisbon, at *Faculdade de Arquitectura da Universidade Técnica de Lisboa*, which pursues the goal of understanding how the carbon neutral challenge is changing present day's urban design and architectural practices. Our purpose is to focus on the design process in order to assess two key questions: 1) How does the desire to meet high standards of sustainability affect the practice of architecture and urban design? 2) Will this global concern with a carbon-neutral future generate a particular architectural language with identifiable physical characteristics regardless of location?

2. Methodology

We have determined as research methodology for our *+E-CO2* research project the analysis of self-acclaimed carbon neutral and/or carbon reduction projects in order to detect how the carbon neutral challenge is affecting the practice of urban and architectural design. The projects which claim to be carbon neutral are the most relevant for our research because, in these projects, the practitioners are guided by the clear purpose of configuring architecture and urban space so as to meet the carbon neutral challenge.

Our analysis derives from the comparative process of design strategies in light of fixed criteria, enabling us to highlight specific design differences and/or resemblances in between the projects. For this paper, we have chosen as fixed criteria the 5 environmental categories of the LEED New Constructions and Major Renovation [1] plus the 3 categories of the LEED Neighborhood Development [2]. In light of these 8 categories, we analyze and compare two very ambitious projects in what regards the carbon neutral challenge.

The first project is the development of a block in Dallas designed by a collaboration of two Portuguese architectural practices (MOOV+DATA), which obtained the first prize in an international architectural competition promoted by the American non-profit organization named "Re-vision". The competition's brief challenged architects to design a project able to become LEED Platinum. Most information regarding the project has been provided by António Louro, one of the architects/partners managing the project [3]. The project's brief was to redesign an urban block in Dallas, including mostly housing, but also commercial spaces and urban equipments.

The second project is the Masdar City development designed by Foster+Partners which aims to become the first carbon neutral city to ever be built. The Masdar City development is located in Abu Dhabi, close to the international airport and was conceived to be carbon neutral, zero-waste, car-free city for 40,000 residents and 50,000 daily commuters. The city is designed for an area of six million square meters. Even if the city is currently under construction (the completion of the first building was announced in November 2010), its scale and ambitious program as a research and institutional hub dedicated to Renewable Energies make it a most relevant project to follow, as noted by Reiche [4]. Data cited in this paper has been gathered from other papers, from the information provided by the company responsible for the development, the Abu Dabhi Future Energy Company [5], by the architects responsible for the masterplan at Foster + Partners [6], and by articles included in architectural magazines [7]. Papers reviewed regarding Masdar City relate to specific technological innovations in the energy field [8], to policies supporting the development [4] or to specific buildings [9]. Prior to this paper, we have presented a paper on the possibility of using some of Masdar City's renewable energy strategies in a "bottom-up" type of development [10]. For the current paper, our approach is different as we aim to highlight the impact of the carbon neutral challenge on architectural and urban design.

We have determined as primary data the information coming from the practitioners or from the entities commissioning the projects. This data must be taken as a set of design guidelines which might not be possible to complete or might change with the project's development (as it has already happened in the Masdar City development with the experimental transport system, originally elevated and currently underground).

We chose to use the LEED categories as fixed criteria due to this rating system's holistic approach and to the system's ability of evaluating projects worldwide; however, unlike the LEED rating system, which aims to provide a quantifiable benchmark to compare each project's efficiency, we aim to assess the impact of the carbon neutral challenge on architectural design; hence, some categories might have no effect on architecture (such as the efficiency of appliances), while others will change the configuration of the city of the future. In Table 1, we present the relationship we created in between the LEED categories and the architectural and urban design strategies of the two case-studies selected. We created a rating system measuring the Impact on Architectural Design (IAD), presenting five classes ranging from IAD 0 to IAD4 where: IAD 0 classifies the strategy as having no or low direct impact on architectural design; IAD 1 classifies the strategy as affecting architectural surfaces using existing design strategies; IAD 2 classifies the strategy as affecting architectural surfaces using new technologies and/or innovative design strategies; IAD 3 classifies the strategy as affecting architectural form using existing design strategies; and IAD 4 classifies the strategy as affecting architectural form using new technologies and/or innovative design strategies.

Table 1. Relationship between LEED categories and architectural and urban design strategies

LEED Environ. Categories (NC=NewConstruction; ND= Neighborhood Development) *The categories which, on both case-studies, did not apply or had NINF were excluded for this paper*	Architectural and Urban Design Strategies *(NA=does not apply; NINF=not enough information; IAD Impact on architectural design 0-4))*	
	Forwarding Dallas	Masdar City
NC - Sustainable Sites		
Construction Activity Pollution Prevention	IAD 0	Impacts assessed + mitigation actions predicted [10] IAD 0
Site Selection	Block within built neighbourhood. IAD 3	6km, built mostly on former plantations land. IAD 3
Development Density and Community Connectivity	Optimizes pedestrian public space + connectivity public space for pedestrians+ bicycles inside the block. IAD 3	Optimizes pedestrian public space + connectivity public space for pedestrians+ bicycles inside the block. IAD 3
Alternative Transportation	No public transport system available. Promotes cyclable public spaces, car-pooling and bicycle parking. IAD 3	Car-free city. New transport system, 2 levels: LRT (aboveground), PRT (undergound). IAD 4
Site Development	Use of native vegetation in public spaces and rooftops. IAD 4	Compact footprint and limited, or walled, perimeter. IAD 3
Stormwater Design	includes vegetative roofs and pervious pavements IAD 4	NINF
Heat Island Effect	Roofs covered with vegetative surfaces. IAD 4	Roofs with shading structures covered by photovoltaic panels. IAD 4
LEED NC – Water Efficiency (WE)		
Water Use Reduction	Rainwater collected and used in agriculture + graywater used in toilets IAD 4	Rainwater collected +graywater used in toilets and cooling of public spaces. IAD 4
Water Efficient Landscaping	Native plant use + drop-by-drop irrigation system + on site measurements to assess irrigation needs. IAD 4	Native Plant use+ Intelligent irrigation systems. IAD 4
Innovative Wastewater Technologies	On-site waste water treatment by gravity-driven mechanical systems + sand and UV light filtration. IAD 4	NINF
Water Use Reduction	NINF	Initial use of desalinized water and recycling of most water in the system. IAD 3
NC -Energy and Atmosphere		
OptimizeEnergy Performance	High energy performing	NINF

	appliances + LED technology IAD 0	
On-site Renewable Energy	On the rooftop - Solar thermal energy + photovoltaic + wind energy. Roof design expands surface to maximize production. Solar cells on the façade. IAD 4	On the rooftop – almost 80% of the consumed energy will be solar. The entire city covered with panels. IAD 4
Enhanced Commissioning	Specialized consultants included. IAD 0	Specialized consultants included. IAD 0
Enhanced Refrigerant Management	Non-mechanical methods of ventilation (cross-ventilation in every apartment). IAD 3	Traditional methods of cooling (such as cooling chimneys) + mechanical cooling. IAD 3
Measurement/ Verification	IAD 0	IAD 0
Green Power	IAD 0	IAD 0
NC - Materials and Resources		
Storage and Collection of Recyclables	Includes area for Storage and Collection of Recyclables. IAD 0	50% waste will be recyclable, 17% will become fertilizers and 33% will not be recyclable. IAD 0
Construction Waste Management	100% pre-fabricated building systems to reduce on site impact and waste. IAD 2	NINF
Recycled Content	Recycled Wood. IAD 2	Materials with a 30% recycled content predicted. IAD 2
Regional Materials	Use of locally produced materials. IAD 1	NINF
NC-Indoor Envirn. Quality		
Minimum Indoor Air Quality Performance Required	Non-mechanical methods of ventilation (cross-ventilation in every apartment). IAD 3	Traditional methods of cooling (such as cooling chimneys) + mechanical cooling. IAD 3
Environmental Tobacco Smoke- Control Required	IAD 0	IAD 0
Outdoor Air Delivery Monitoring	IAD 0	IAD 0
Controllability of Systems—Lighting and Thermal Comfort	Operable Windows and Window Protections IAD 2	NINF
Thermal Comfort—Design/Verification	Northeast façades in high thermal mass straw walls. IAD 2	NINF
Daylight and Views	Block designed to maximize daylight and views. Windows consider southern orientation and permanent shading	NINF

	devices. IAD 3	
NC/ND -Innovation in Design		
Innovation in Design	Educational project IAD 0	Educational project IAD 0
LEED Accredited Professional	Goal to obtain LEED Platinum IAD 0	NINF
NC/ND-Smart Location and Linkage		
Smart Location	Block within existing neighborhood in Dallas. IAD 3	New development on previously planted land close to national transport infrastructure (airport). Max. walkable distance from the planned PRT stops is 150m. IAD 4
Imperiled Species and Ecological Communities	NA	Loss of existing habitats predicted. Mitigation actions predicted. IAD 3
Wetland and Water Body Conservation	NA	No significant effects predicted in the initial stages. IAD 0
Agricultural Land Conservation	NA	Located predominantly on abandoned plantations. IAD 3
Preferred Locations	Existing City. IAD 3	Located predominately on abandoned plantations – new infrastructures considered. IAD 3
Locations with Reduced Automobile Dependence	Included in city with high automobile dependence. IAD3	Car-free city. IAD 4
Bicycle Network and Storage	Predicted. IAD 3	Mostly walkable distances. IAD 3
Housing and Jobs Proximity	Mostly residential (dwellings and support areas = 303658 sq.f; commercial, equipments and greenhouses 101828 sq. f, parking 68867 sq. f). IAD 3	Mixed-use development (30% residential; 20% tax-free enterprises; 10% commercial services; 3% cultural equipments, 3%university , 34% with parking, services, recreational spaces, and other areas). IAD3
Site Design for Habitat or Wetland and Water Body Conservation	NA	Loss of existing habitats predicted. Mitigation actions: creation of new habitats with native species through the greenfingers + retention of desert habitat outside citywalls + healthy native plant specimens translocated to Masdar's nursery. IAD 3

Restoration + Long Term Conservation Management of Habitat or Wetlands and Water Bodies	NA	Mitigation actions predicted. IAD 3
ND-Neighborhood Pattern + Design		
Walkable Streets	Pedestrian space within the block. Ground level with commercial and other equipments with glass façades. IAD 3	Car-free city. Most of the transport system is underground to free public space for pedestrians. IAD 4
Compact Development	Increases footprint IAD 3	Compact footprint with rigid physical limit perimeter to prohibit urban sprawling. IAD 3
Connected and Open Community	Block designed (sectioned) to increase existing connectivity. IAD 3	Requirement to place every pedestrian at a distance of 150m from a PRT station in any given location increases connectivity. IAD 4
Mixed-Use Neighborhood Centers	NA	Mixed-use. Centers related to transit system. IAD 3
Mixed-Income Diverse Communities	Dwellings range from studio to 3 bedroom flats IAD 3	NINF
Reduced Parking Footprint	Reduced surface parking IAD 3	Parking outside city walls IAD 3
Street Network	Block designed (sectioned) to increase existing connectivity. IAD 3	Every pedestrian at a distance of 150m from a PRT station in any given location. IAD 4
Transit Facilities	Promotes cyclable public spaces, car pooling and bicycle parking. IAD 3	Car-free city. Underground Urban Transit to free public space. IAD 4
Transportation Demand Management	Promotes vehicle sharing. IAD 0	Use of Urban Transit System. IAD 4
Access to Civic and Public Spaces	Public space inside the block. IAD 3	Due to the underground characteristic of the transit system, most public space will be passive. IAD 4
Access to Recreation Facilities	Recreational facilities within the block. IAD 3	NINF
Visitability and Universal Design	Several types of dwelling units /concern with mobility. IAD 3	NINF
Community Outreach and Involvement	Calls for an holistic design approach. IAD 0	NINF
Local Food Production	Includes local food production on the rooftops. IAD 4	Includes local food production outside city perimeter IAD 3
Tree-Lined and Shaded Streets	Tree-lined streets. IAD 3	Main streets are tree-lined; other streets are shaded and

		narrow. IAD 3
ND-Green Infrastructure + Buildings		
Certified Green Building	Goal:LEED Platinum. IAD0	Goal= Carbon Neutral IAD 0
Water-Efficient Landscaping	(= LEED NC IAD 4)	(= LEED NC IAD4)
Minimized Site Disturbance in Design and Construction	NINF	Mitigation actions predicted. IAD 0
Heat Island Reduction	(= LEED NC. IAD 4)	(= LEED NC. IAD 4)
Solar Orientation	East-west axis 5xlonger than north-south axis. Block orientation greater than 15º from the geographic east-west. IAD 3	Narrow streets and compact design. IAD 3
On-Site Renewable Energy Sources	On the rooftop – Solar thermal energy + photovoltaic + wind energy. Roof design expands surface to maximize production. Solar cells on the southwestern façade. IAD 4	On the rooftop – almost 80% of the consumed energy will be solar. The entire city covered with panels. IAD 4
Solid Waste Management Infrastructure	Organic waste used as fertilizer (predicted). IAD 0	Organic waste used as fertilizer (predicted). IAD 0

3. Results

Two types of results can derive from Table 1. The first result is that all items classified as IAD 4 (with one exception) regard either the use of rooftops or the planned transport system (e.g. Table 1). The second result is a high frequency of strategies classified as IAD 3, followed by IAD 4 and IAD 0, with only a few items classified as IAD 1 or 2 (e.g. Fig.1).

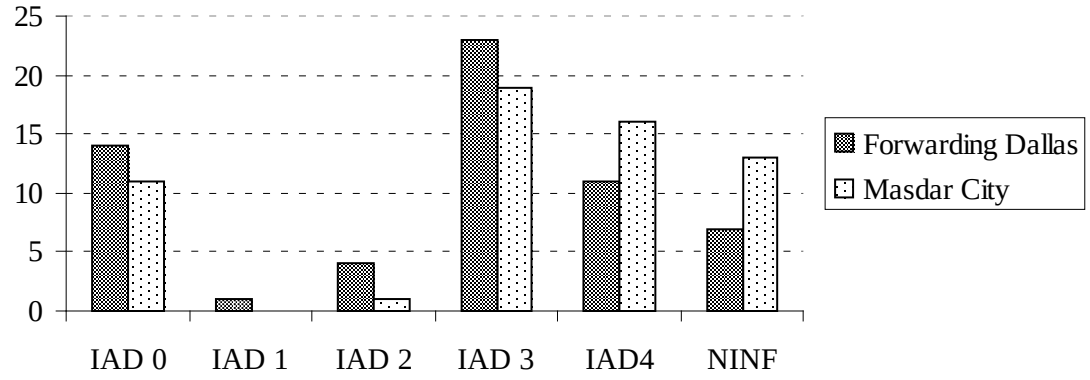

Fig. 1 Frequency of IAD (Impact on Architectural Design) according to classes (IAD 0 to IAD 4)

4. Discussion and Conclusions

Based on these results, we can argue three conclusions. The first conclusion is that two new technologies which might become a trademark of the city of the future are: the increased relevance of the rooftop as a "productive surface", with the potential to collect energy and rainwater, and to provide spaces for plantation; and the inclusion of intelligent urban transport systems, allowing public space to be car-free. This conclusion is based on the indication that

almost all strategies classified as IAD 4 are related either to rooftops or to the urban transport system. The second conclusion derives from the low frequency of IAD 1 and IAD 2, indicating that fewer design strategies are related to the surface of the architectural object (or to the architectural skin) as compared to the configuration of the architectural from. Most strategies used by the selected practitioners to comply with the LEED categories fall under IAD 0, IAD 3 or IAD 4; hence, there is either no impact on architectural design (IAD 0) or a profound impact on the configuration of architecture (IAD 3 and IAD 4). The third conclusion derives from the high frequency of strategies classified as IAD 3 (e.g. Fig.1), indicating that the selected practitioners are using existing or traditional design strategies to relate architecture effectively to climate and location.

What we believe to be particularly interesting about these results is that the first conclusion has the potential of becoming global in its application as practitioners all over the world (literally) turn their projects to the sun and build intelligent urban transport systems, while the third conclusion indicates a promotion of local characteristics; hence, the carbon neutral city of the future might present an architectural language which incorporates both global and local design characteristics, a language where tradition meets technology to achieve a most efficient architectural design.

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