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A review of Islamic Traditional and Contemporary Dwellings in Hot Climates, with Reference to Benghazi, Libya

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Outline

- Aim of the research
- Methodology
- Islamic traditional houses
- Climatic design
- Benghazi (case study)
- Research problems
- The survey
- Conclusion
The overall aim of the study is to investigate the main features of traditional Islamic houses, which can enhance environmental comfort and reveal insights when compared with contemporary houses.

- Traditional Islamic dwelling
- Current contemporary dwelling
## Methodology

<table>
<thead>
<tr>
<th>Step</th>
<th>Method</th>
<th>Type and material</th>
<th>Results were achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>literature review</td>
<td>Previous research, articles, journals, and books</td>
<td>Determine and understand the main principles sustainable social-cultural and climatic design in traditional Islamic houses.</td>
</tr>
<tr>
<td>2</td>
<td>Quantitative</td>
<td>Questionnaires (60 surveys with local residents)</td>
<td>Determine the physical environment and human behaviour regarding to thermal comfort and privacy in houses</td>
</tr>
<tr>
<td>3</td>
<td>Analysis</td>
<td>Data collected, analysed</td>
<td>Determine the main environmental principles of traditional Islamic housing design, which can implement in contemporary houses to enhance environmental comfort (orientation, openings, and internal open spaces).</td>
</tr>
</tbody>
</table>
1. The main features in Islamic traditional houses

1. The compact system and narrow and irregular streets.
2. The open interior domestic courtyard gives an acceptable environment for the residents with regard to temperature, and privacy.
3. Orientation of courtyard can decrease the temperature indoors and outdoors from 46 °C to nearly 30 °C (Edwards et. al., 2006).

- Traditional urban fabric based on courtyard housing
- The orientation of the courtyard is longitudinal axis (East-West) for the sun movement.
4. Courtyard includes pool and plants, which can help with orientation to decrease indoor temperature.

5. Passive cooling in traditional houses is by natural ventilation between courtyard and small high openings (Heidari, 2010).

- Air circulations
- The sun projection during summer days
6. Building envelope and materials, local materials were used to build traditional houses (brick, stone, palm trunks, and wood) which have physical properties to act as thermal insulators with thick external wall and minimum external windows.

   - A street view of courtyard housing showing the high-level of the small openings (Edwards et. al., 2006).
1. Building form

A building form is responsible for up to 35% of the reduction in energy demand (Tereci, el., 2013).

2. Orientation

The size of W-E facades should be less than the size of facades facing north and south (Tereci, el., 2013).

- Sun movement (solar radiation).
- Wind direction (natural ventilation).
3. Courtyard

a) Koch-Nielsen draws a recommended width of the courtyard that ranges from $x$ to $3x$, having $x$ the courtyard height.

b) Aspect Ratio ($AR$) = area of the courtyard floor (m²) 
   (Average height of surrounding walls) 
   ($AR = 5$ to $8$)

A 3D view of the six simplified house/yard combination types (Malekzadeh, 2008).

Comparative outdoor thermal comfort of all house types
Benghazi as case study

• City of Benghazi is the second largest city in Libya, and the capital of the eastern region of Libya.

• Benghazi has a typical of the Mediterranean climate, Mild winters (5–18 °C) and dry, hot summers (23–38 °C).

• Benghazi has 631,555 populations.

• The highest population density, 2000 inhabitants/km² (Agll et al., 2014).

• Yearly, housing demand, from 24,000 units to 38,000 units (2000 – 2025) (UPA, 2006).

<table>
<thead>
<tr>
<th>Building by type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flats</td>
<td>39.50%</td>
</tr>
<tr>
<td>Private houses</td>
<td>60.50%</td>
</tr>
</tbody>
</table>

Houses by Type, Benghazi, 2006 (Mohamed, 2013)

Location of Benghazi (Agll et al., 2014)
a) Housing design changes

- Excessive use of air conditioning and glazed windows
- Close most of the balconies with big glazed windows (privacy)
- Not to use balconies (privacy)
- Use outdoor open space and not considering with orientation of house
Contemporary villa in Benghazi

Using artificial lighting

Using big glazed windows

Reception room opened to living room

Design open plan

Indoor

Outdoor

No shading and privacy

Outdoor seating area

Unused swimming pool

Entrance of villa
b) Energy consumption


- Carbon dioxide emission per capita, MDG indicator. Source UN statistic, Division/CDIAC (GABRIL, 2014).
The main findings of the survey

- On January 2016, the survey was distributed randomly in two different neighbourhoods (apartments and villas).

- The size of samples was 60 pilot surveys (30 for apartments and 30 for villas).

The percentage of preference to live in villas

- If your house is a villa, did you live in an apartment before? Yes: 70%, No: 30%
- If your house is an apartment, would you move to a villa? Yes: 88%, No: 13%

What is the building material of your house?

- Concrete: 100%
The main findings of the survey

If your house has open space, is it?

- 89% outdoor
- 4% indoor
- 7% both

Are you satisfied with the level of privacy in your open space (between your family and neighbours)?

- 11% Not at all satisfied
- 70% slightly satisfied
- 48% moderately satisfied
- 7% very satisfied
- 0% Extremely satisfied

Who designed your villa?

- 15% Architect
- 19% Civil engineer
- 30% Contractor
- 33% Repeater design

The number of windows, doors, and balconies in all facades of villas

- North facade:
  - Window: 81
  - Door: 8
  - Balcony: 5

- East facade:
  - Window: 100
  - Door: 13
  - Balcony: 3

- West facade:
  - Window: 94
  - Door: 21
  - Balcony: 4

- South facade:
  - Window: 66
  - Door: 12
  - Balcony: 6
The main findings of the survey

### The usage of balconies

<table>
<thead>
<tr>
<th>Function</th>
<th>Flats</th>
<th>Villas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Clothes dryer</td>
<td>26%</td>
<td>41%</td>
</tr>
<tr>
<td>Storage</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>Playing space</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>Rare use</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Type of cooling mechanical system in houses

<table>
<thead>
<tr>
<th>System</th>
<th>Flats</th>
<th>Villas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable fan</td>
<td>29%</td>
<td>0%</td>
</tr>
<tr>
<td>Roof fan</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Air conditioning unit</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Are you satisfied with the level of privacy in balconies (between your family and neighbours)?

<table>
<thead>
<tr>
<th>Satisfaction Level</th>
<th>Flats</th>
<th>Villas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all satisfied</td>
<td>8%</td>
<td>11%</td>
</tr>
<tr>
<td>Slightly satisfied</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Moderately satisfied</td>
<td>38%</td>
<td>19%</td>
</tr>
<tr>
<td>Very satisfied</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Extremely satisfied</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### In what season(s) is the Air Conditioning system used?

<table>
<thead>
<tr>
<th>Season</th>
<th>Flats</th>
<th>Villas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Winter</td>
<td>0%</td>
<td>19%</td>
</tr>
<tr>
<td>Autumn</td>
<td>46%</td>
<td>70%</td>
</tr>
<tr>
<td>Spring</td>
<td>50%</td>
<td>89%</td>
</tr>
</tbody>
</table>
Using outdoor spaces
Using many glazed windows
Incorrect orientation
Increase of indoor temperature
Increase of use of air conditioning
Increase energy consumption and CO2 emission

Different designs
Number and form of windows
Orientation of windows
Different locations
Type, color, and ratio of glass
East-west direction of indoor open spaces

Decrease energy consumption and CO2 emission
Decrease of use of air conditioning
Decrease of indoor temperature
Decrease of use of air conditioning
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Decrease of indoor temperature

Contemporary Islamic dwellings
Traditional Islamic dwellings
Thank you