House Typology from Adjacency Diagram Theory to Space Orientation Theory

Emad S. Mushtaha¹, Mohammad S. Arar²
¹,²Assistant Professor, Department of Architectural Engineering
Ajman University of Science and technology, UAE

Abstract— No attempts, so far, has been made to analyze the indoor spaces of a house from the perspective of geographic direction. There are few studies in a house typology based on indoor space distribution. Many tools like Adjacency Diagram Theory (A.D) and Analytical Hierarchy Process (AHP) were used by the author to typologize architecture. In general, these attempts ignored the true direction of spaces from its hypothesis. Therefore, this paper will develop the Adjacency Diagram Theory to consider the true geographic direction of spaces in the analysis. An experimental case of a corridor-plan has been deeply investigated using both theories. Accordingly, the outcome of the analysis has shown that the number of patterns using Space Orientation Theory is greater than those patterns of Adjacency Diagram Theory by 196:30 respectively. As a result, house patterns based on Space Orientation Theory is more comprehensive and effective, and it is worthy to use it in counting patterns. This approach adds a new room for house typology and helps find the summer, winter, and summer-winter patterns easily. It is advisable that decision makers, planners, architects and architecture students study this theory and use it in future house design.

Index Term-- Adjacency Distribution Theory; Analytical Hierarchy Process (AHP), Space Orientation Theory; Corridor-Type Plan, House Typology

I. INTRODUCTION

The architectural typology of houses is widely understood that it is a circumstance of repeating characteristics of some elements and/or spaces regularly more than others in housing planning and design. These frequencies have been based on people satisfactions, psychological feelings, and/or scientific theories that control the arrangement. Tools like: the application of Analytic Hierarchy Process (AHP) [1], [2] and the Adjacency Distribution Theory [3] were used to help find out an accurate typology approach. This paper introduces a new approach which has not been used before. As orientation of space affects typology of plans and classifies it in groups, the true geographic direction has been considered in the study. This would develop the first study of Mushtaha 2010 [3] and add a room for establishing an accurate definition of architectural typology that could be used in future design. Therefore, in this paper the Adjacency Distribution Theory developed by Prof. Kurosawa’s research [4] and used by Ahmed, M. [5] is a subject for change where the geographic direction/orientation will be considered not ignored. Herein, the study aims at searching more layouts and typology varieties which enhances people to have an opportunity in selecting more choices. The following Fig.1 shows a common Corridor-Type Plan in Gaza city taken as an experimental plan but other plans could be used if required.

II. PURPOSE OF The STUDY

The study aims to achieve guidance for future design through the following means:
2.1 Achieving more patterns to enhance selecting more choices, and finding an accurate tool to define patterns.
2.2 Connecting the Space Orientation Theory with the geographic direction makes architects aware of climate and helps them in designing accordingly.

III. INDOOR SPACES OF CORRIDOR-TYPE PLAN

From the common plan Fig.1, it is found that four zones of guest, living, bedrooms, and services areas forms indoor spaces which are connected by corridor.

• Guest Area (GA) The guest area consists of a guest room plus additional space for a special toilet and sink.

• Living Area (LA) The living area consists of a living room in addition to its required spaces: the corridor and balcony. This living space has been positioned mainly beside the entrance, which has two opposite routes for the living and guest rooms.

• Sleeping Area (SA)
Over a half of the Gazan society has three bedrooms as an average, for parents and children (female and male).

- **Services Area (KB)**
  It consists of wet areas like (kitchen and bathroom or toilet). In most cases, a kitchen has been set beside the living space.

IV. THE ADJACENCY DIAGRAM THEORY (A.D)

The Adjacency Diagram shows the circulation and space distribution in the plans. This method is to typologize and categorize architectural plans. To draw the A.D, several drawings are explained at Mushtaha 2010 [3] but rearranged in this paper in order to make the study smooth and consistence. The following are the steps required to draw the Adjacency Diagram:

- **Draw Circulation Diagram**
  The diagram in Fig.1 shows the distribution of internal zones: living area (LA), guest area (GA), and wet service area (KB), also shows circulation process from the entrance to another. To simplify reading the main access to the house, one main entrance is considered for the house from the staircase Fig.1. In the figure lines represent the access from one zone to another.

- **Draw Circulation-Grid Diagram**
  To simplify understanding the process, Fig.2 shows the distribution of zones and the possible circulation from one zone to another in a grid. The two diagrams are combined together in Fig.3, which represents the direct access from one zone to another in bold lines, while the possibility of access, indirect access, from one zone to another in dashed lines.

- **The Adjacency Diagram (AD)**
  Zones are rearranged in a circumference where the adjacent zones are shown in sequence Fig.4. The corridor (Cr) is the central cell of the house that has possible access to all other spaces and zones.

- **Setting Bedrooms into the (AD)**
  Bedrooms average is approximated to 3 bedrooms in the house. The positions of those rooms are different as shown in Fig.5. To find out the possible permutation of bedrooms in a circumference of a house, the mathematical factorial equation is used.

- **Calculate the number of patterns without bedrooms**
  If bedrooms (Br) are not added to the circumference, and position of (LA) and (Cr) is considered constant in the circle, then the other circled spaces will change positions. Therefore, to calculate the number of patterns, the simple mathematical formula of Factorial of 3 can be used as follows:
  \[ 3! = 3 \times 2 \times 1 = 6 \text{ patterns} \]
  Then, the number of patterns of the factorial of 3 is 6. But, in fact those 6 patterns are actually 3 patterns and their mirrored forms; therefore we consider only 3 basic patterns: A, B, and C as shown in Fig.6. It is noticed that most Gazan houses have the direct access to the guest area (GA) through the staircase (S), which is the main entrance to the house (E). So (GA) and (E) should be adjacent in the circumference of the circle.

- **Calculate the number of housing patterns with bedrooms**
  Locations of bedrooms are different and might be gathered within one to two zones between spaces. There are spaces in the circumference of the circle between four of the five basic requirements of the house, (LA, KB, E, GA), those spaces are numbered (clockwise) from 1 to 4 to mark the locations of bedrooms (Br), when they are added to the diagram. When bedrooms (Br) are added, then the sub-types of each pattern can be easily named.
  For example, if 3 bedrooms are added in position (1) of Type A, then the sub-type is named as Type A1-1-1 as in Fig.7. Also, if two bedrooms were added in positions (1) and one bedroom was added in the position (2) of Type A, then the sub-type could be named as Type A1-1-2. To calculate the number of sub-types of each basic type (from Type A to Type C), 19 sub-types for each of our 3 patterns are found Table.1. For instance, for Type A, it is found that 9 types within brackets are not found where no bedrooms are located between the entrance or staircase and guest room as the access to the guest area (GA) would be always through the staircase.
There would be 10 sub-types for each basic type (3 basic types from Type A to Type C) and the total number of types would be 30 types. Therefore, there would be 10 sub-types for each basic type (3 basic types from Type A to Type C) and the total number of types would be 30 types. Fig. 8. Herein, imaginary diagrams are drawn and shown in Fig. 9 to simplify reading Fig. 8.

V. HYPOTHESIS OF SPACE ORIENTATION THEORY
This hypothesis develops the Adjacency Diagram Theory by considering the true direction of all spaces. This could help achieve the summer, winter, and summer-winter patterns found.
at Mushtaha 2006 as Gaza has extreme values of both cold and warm percentages during the year [6]. Throughout the analysis of Gazan architecture, it is found that most spaces are arranged as in Fig.10. It is noticed that the entrance is close to the corridors and living spaces. Those spaces are connected directly to the guest spaces with a different access. Bedrooms could be located between (KB) and (LA) or other spaces except between the entrance and guest room. To ease reading the diagram, the authors would fix the entrance (Ent) with the inside-corridor (Cr) as a constant zone, and the entrance (Ent) with the living area (LA) as a constant zone. This helps account all units patterns easily. The authors hypothesize first: the main spaces rotate clockwise in four directions Fig.11 like earth rotates around sun causing seasons, and second: the other sub-main spaces accordingly rotate among themselves like earth rotates around itself causing day and night Fig.12. When bedrooms are added to the diagrams mentioned at can draw from the orientation of spaces in a house, and at the same time relate these orientations to the climatic aspect of all Fig.10, then the number of patterns can be increasingly as shown in Fig.12. Generally, housing patterns based on space orientation for the corridor-type diagram can be counted to 196 types as:

Type A: \( A + A_1 + A_2 + A_3 = 10 + 10 + 10 + 19 = 49 \) types
Type B: \( B + B_1 + B_2 + B_3 = 10 + 10 + 10 + 19 = 49 \) types
Type C: \( C + C_1 + C_2 + C_3 = 10 + 10 + 10 + 19 = 49 \) types
Type D: \( D + D_1 + D_2 + D_3 = 10 + 10 + 10 + 19 = 49 \) types

This method gives more varieties of plans which are climatically interpretable. To do so, another research on living style is highly needed to focus on summer, winter, and summer-winter spaces. This is to help reduce energy use in homes if all patterns are found. This is just a starting point for a comprehensive research to cover the issue of energy within planning and design of living environments.

<table>
<thead>
<tr>
<th>Main Types</th>
<th>1-1-1</th>
<th>1-1-2</th>
<th>1-1-4</th>
<th>1-2-2</th>
<th>1-2-4</th>
<th>1-4-4</th>
<th>2-2-2</th>
<th>2-2-4</th>
<th>2-4-4</th>
<th>4-4-4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Type B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Type C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 8. Main Types Based on Adjacency Diagram Theory with Bedrooms

VI. CONCLUSIONS
Throughout the analysis covered both Adjacency Diagram Theory and Space Orientation Theory, conclusion can be drawn as follows:
1. This approach high light the alternatives that the architect can draw from the orientation of spaces in a house, and at the same time relate these orientations to the climatic aspect of all year around from summer to winter and the advantages of controlling these orientation according to the needs.
2. Space Orientation Theory is a holistic approach for typology, and more accurate and comprehensive than the theory of Adjacency Diagram. Orientation Space approach is simple, flexible and accessible, as it has more alternatives than those
3. This study adds a newly practical definition of a climatic house where people can select the orientation of their space to attain interest either to live in summer, winter, or summer-winter type. This makes a society aware of their climatic architecture and typology.

4. The approaches described previously help specialists understand their architecture by having all types summarized into a small table. As a result, people can locate their plans on the table and identify the common types of house units.

5. The need to study and analyze more existing contemporary, vernacular, and traditional plans would strengthen the finding. It is recommended to implement it into the architecture education to understand typology correctly.

6. The Adjacency Diagram approach is further developed and included the geographic directions. This increased the number of house patterns that people can have more alternatives and typologies. The authors would encourage all researchers to generalize this approach to different locations over the world in their future researches.

<table>
<thead>
<tr>
<th>Main Types</th>
<th>A 1-1-1</th>
<th>A 1-1-2</th>
<th>A 1-1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 9. Main Types of Units Using the Adjacency Diagram Theory with Bedroom Distribution
Continued Fig. 9. Main Types of Units Using the Adjacency Diagram Theory with Bedroom Distribution
REFERENCES


Dr. Mushtaha studied architecture at Islamic University of Gaza where he received his B.Arch. For Municipality of Gaza, he worked as an architect and urban planner at Department of Urban Planning for several years. During his short stay, he gained a tremendous experience on space management and government regulation required for Gaza city such a high-density area. Following his postgraduate studies, he received his Master and PhD Degree in the field of Architectural and Environmental Studies from Hokkaido University, Japan. Dr. Mushtaha also received in 2006 a prestigious Postdoctoral-JSPS Fellowship for two-years from Higher Education of Japan to conduct a research on Universal Design’s Requirements of the Elderly People and people with special needs. On global level, he has participated in many conferences and published many articles and papers in different magazines, refereed journals and conference proceedings. Also, he managed many international workshops on architecture and green buildings. Currently he is working for Ajman University of Science and technology and has conducted various design projects some of which were awarded, like Estidama Context 2009, besides his teaching duties both on Sustainable Architecture and Housing Theory and Design as well as design studios. His current interests include urban housing design and sustainable architecture. He can be contacted at: e.mushtaha@ajman.ac.ae, emad27270@hotmail.com

Dr. Arar is the head of the architectural Engineering Department at Ajman University of Science and Technology. He finished his PhD study in the field of Environmental and Urban Studies at Rensselaer Polytechnic Institute in Troy, New York. The title of his PhD study was “Computerized spatial analysis for settlements development”. Dr. Arar was an assistant professor in the architectural engineering department at Applies Sciences University in Amman, Jordan. He was the head department in the year 2000-2001 at that university. Then, He worked as a consultant architect and researcher in Canada. His interest was in monitoring and forecasting the new developments that took place in certain area around Toronto city and Mississauga city and the water front zone in Ontario provinence. His experience in architecture goes back to mid eighties when he finished his undergraduate study with two bachelor degrees, one in architecture and the other in city and regional planning from the University of Louisiana, Lafayette, USA. His focus was to combine the architectural practice with urban planning issues. He finished his master degree in architectural design from California State Polytechnic University, Pomona, Los Angeles, USA. He worked as an architect in one of the biggest residential project in Jeddah City Saudi Arabia. Dr. Arar worked as a lecturer in the Architectural Engineering Department at Jordan University of Sciences and Technology in Irbid City, Jordan. His main interest at the department was to do research that deals with urban planning and urban design. He can be contacted at: m.arar@ajman.c.ae, msarar@hotmail.com