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Directionality of the Traditional Urban Fabric -Mosul as a case study-

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ABSTRACT

Traditional and historical cities have been under extensive research for a fairly long time. Many studies tried to capture the rules standing behind their form, structure and organization, and have taken different methods and procedures to reach their goals. In this study, one of these concepts has been chosen, the directionality, a path that has not been followed to its appeased limits. The urban fabric has been viewed through the element of direction as a result of the design process, and the concept of directionality as an architectural and urban formulator. Since the traditional cities had gone through multiple and diverse circumstances through ages, it would be expected to see different effects for these various factors (environmental, social, geographical and political), all viewed through the extent to which they might affect the direction and the orientation of the cities' masses and spaces, and shaping the city as a whole. The study has been applied on a case study, represented by the old city of Mosul, which has a long urban history; starting from being an Assyrian military camp, to an Islamic capital, each culture had its effect on the city's fabric, and thus on its pattern.

Keywords: Directionality, Orientation, Urban fabric, traditional cities, Mosul.

1. INTRODUCTION TO DIRECTION AND ORIENTATION

The term (direction) is extensively used in architecture. Architects and architecture students apply the concept of directionality and the term orientation, to decide the layout of their designs. The dictionaries put several levels of definitions for the term, from being a path to be moved along, to an explicit order to be followed. In terms of design and architecture, the words direction and orientation usually refer to the relationship between an object and a point of compass, and (orientation) has been used to get the maximum advantage of the climatic variations [1].

Going back to the historical implications of the concept, we can find clues of 'respecting a specific direction' for several reasons. Starting with the Egyptian architecture, we can find that the most important buildings in the Egyptian civilization, the pyramids and the temples, were facing the four cardinal directions. This tradition was followed for a religious reason; since they believed in life after death, and that the east represented life and the west the death [2].

Most of the courtyards of the ancient Chinese architecture were facing south, along with their temples, and for more than one reason; the first was being the best environmental orientation, and the second was a spiritual one, since north was the source of the barbaric tribes [3].

In the Greek architecture, Spreiregen [3] argues that the Greek temples had no specific respected orientation for their temples, but most of them were built on top of mountains or hills, reflecting on the spiritual connection between man and the direction to the heavens.

Overall, we can find directionality as a regulating factor for some of the most important buildings in almost each ancient civilization, affecting the urban factor as a whole. In addition, and even in modern architecture, the religious or the environmental factors, and their effects are obvious and clear.

2. DIRECTIONALITY ON THE URBAN LEVEL

Many examples can be found, regarding the effect of directionality on the urban fabric, mostly for the same reasons mentioned in the architectural section. For example, the roman cities were known for their strong order and regularity, and most of these cities were designed depending on two main streets, (Decumanus Maximus) which runs on a north-south axis, and the (Cardo Maximus) which runs along the east-west axis, for social and religious reasons. This also may result into directing most of the cities' masses and plots towards the same direction [4].

(Michael Smith) considers the orientation a design concept, and mentions many examples of settlements that were planned merely depending on this element. (Takwa) a Kenyan village, fig (2), has all its buildings oriented towards one specific direction, and according to him, most of the buildings in (Mesoamerica) were oriented towards (17 degrees) east from north [5]. Mohenjo-Daro, an ancient city in the Indus valley, also respected a specific direction. One study states that the cities' alleys were planned in respect of the northern winds, which would push the hot air out from the streets and the courtyards [6].

In 1585 (Sixtus V) was appointed as the Pope, and he decided to re-design the city of Rome. He opened new streets between the most important churches and cathedrals, which made the city take a new form. This new direction-based procedure, between scattered points (churches), is what shapes the city of Rome today, as seen in fig (1) [4].

It is important to mention that even some of the modern cities have the same concept applied. Ali and Hill [7] mention that the Capitol building stands along an east-west axis, connecting it with the Washington monument. Moreover, the Pennsylvania Avenue, which links the Capitol with the White house, is also directed towards the summer sunset angle [7]. The city of Jeffersonville was re-planned by president Jefferson in 1802. He wanted to increase the level of the sanitary quality of the city, so he changed the angle of the streets to be parallel to the prevailing wind direction, changing the whole layout of the town [3]. Another example can be Manhattan, New York, where the streets have a rectangular grid pattern, directed towards the four cardinal directions [4]. Brasilia, Brazil's capital was planned in respect of the site's topography, and the city's plan had a triangular form, with one of its arms on the east-west axis, the second directed towards the north, and the third towards the south [8].

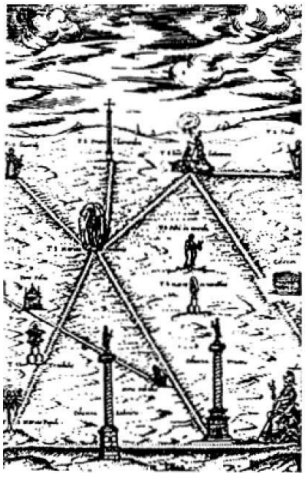

Fig 1: **The effect of Sixtus V on Rome**, [4: 51].

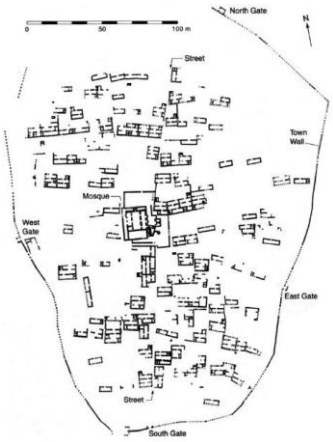

Fig 2: **Takwa in Kenya**, [5: 9].

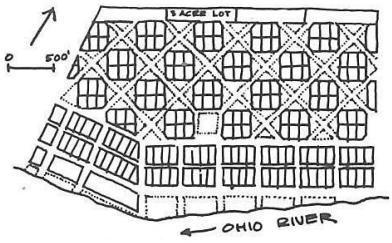

Fig 3: **Jeffersonville after the changes made by the president**, [3: 31].

As mentioned previously, the factors affecting an urban fabric's orientation can be diverse. These factors may derive from the location's geography, like the topography of the site. Other factors might include the environmental factors, religious influences, political choices by the rulers, or in some less frequent cases, the designer's choice, and no matter what these effects can be; it results on the form of the city as a whole, proposing a new perspective from which these cities can be viewed, or even classified.

3. TRADITIONAL CITIES AND THEIR URBAN FABRIC

Traditional cities are different from the modern 'planned' cities. Saarinen [9] argues that we ought to differentiate between emergence of cities, and planning of cities. In his approach, he indicates the difference between the modern planned cities, and the traditional cities, which have been built through hundreds of years.

In his study, Spreiregen [3] refers to the relationship between a city's function and its planning pattern. He argues that when the settlements' inhabitants worked in agriculture, the rectilinear pattern was preferred, since it made it easier to divide and redistribute the lands among the farmers. While, when the settlement was a hunting or of a pastoral function, the radial pattern was chosen, because the circle was the best shape for the security of the animals and the inhabitants [3].

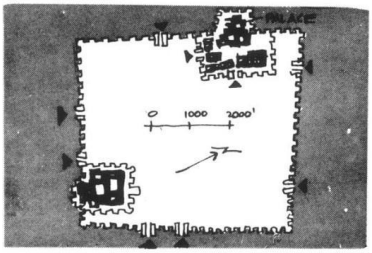

Fig 4: **Rectangular cities' pattern**, [3: 2].

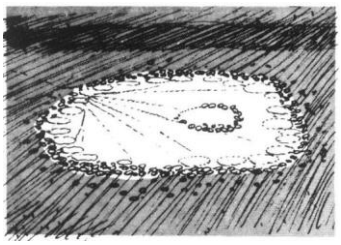

Fig 5: **Circular or Radial cities' pattern**, [3: 2].

What makes the traditional cities unique is their complexity on many levels. The irregular, organic traditional cities can be seen in every corner of the world. And many studies tried to investigate the rules standing behind this so called 'random' complex shape.

Some argue that this complicated, irregular pattern was chosen, for its efficiency in the times of wars, making protection the primary goal [9]. Others suggest a different opinion, and refuse to describe these organic streets and alleys as 'random', suggesting a connection between them and the human subconscious. The study proposes that these staggered lines represent the natural paths drawn by people walking without any restrictions, sometimes with their animals. People, through their usual daily movement, chose these paths naturally without being blocked by buildings, and affected mainly by the terrain. Later these paths would become streets and alleys [10].

Moughtin [11] suggests a different opinion. He mentions that (Alberti, 1485) emphasized the beauty of the organic planning, suggesting a deliberate organic planning. He argues that the organic pattern of streets helps a person to see more, view more details, and sense strength and prestige of the beauty of the design. Same opinions of other urban planners like Gaudi and Camillo Sitte, have been mentioned in other studies [4], suggesting an aesthetic reason behind this complicated form.

4. THE ORIENTATION OF THE URBAN FABRIC IN THE ISLAMIC CITY

Few studies tried to capture the effect of Islamic instructions on the orientation of the urban fabric within the Islamic city. One, achieved by David King on the sacred direction, Al-Qibla, where he mentioned that if we looked to a traditional Islamic city we will see that a big part of its architecture is not facing Mecca although that is what scholars believe in. Other scholars interpret that as a result of ancient Muslim scholars' poor mechanisms for determining the exact location of Mecca, while King argues that the medieval Muslim scholars were able to determine the location within a few minutes of arc so that can't be the cause. He concluded that there were many Qibla directions within one city. The first is Mecca's location, the second is towards south (the prophet Mohammed prayed towards south after leaving to Medina which is north of Mecca) and the third is the summer sunrise and sunset (which the Qibla directions in many regions were and which is also the orientation of Kabaa). King showed his theory in Cairo where he pointed to 3 different directions in its pattern, each in respect of a specific Qibla as mentioned above, (fig 7) [12].

A study done by Michael Bonine on Islamic cities in Morocco where he studied the directionality of six traditional Islamic cities, Bonine found that three of the six cities were oriented to Qibla. He concluded that the major reason the three others were not directed was the factor of topography, he concluded that the Islamic sacred direction (Al-Qibla) was the main factor in

determining the directionality of Islamic cities after topography. One of these cities can be seen in (fig 6) [13].

In his study on Samarra (an Islamic capital), Kettana found that most of the city's streets were directed towards the north while most of the important structures like huge palaces, administrational buildings and citadels were oriented towards Qibla [14].

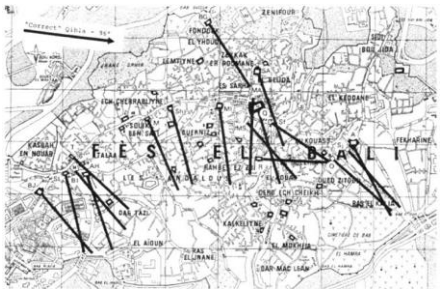

Fig 6: **The directions of the mosques in a Moroccan Islamic city**, [13: 57].

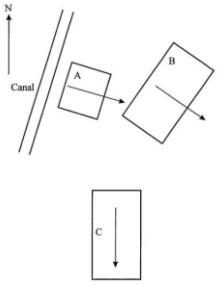

Fig 7: **Cairo and its three directional patterns**, [12: 265].

Some other studies even go further and points that Islam may affected the plans of Muslim private houses orienting them to Qibla since the idea was common [15].

5. THE RESEARCH'S PROBLEM AND OBJECTIVES

The main issue in the literature viewed is that most of the studies tried to describe cities' forms, and analyze the different factors leading to it, with directionality being mentioned as a secondary factor, or merely a result for other more effective influences. Other studies tried to capture the orientation of the urban fabric, with concentration on a single side, leaving the results of the collective effect of all the factors working together, out of picture.

In this study, the traditional urban fabric of Mosul has been chosen, and the Space Syntax methodology will be used. The syntactic analysis of the urban fabric can show the inner structure of the system. This technique would be more effective to view the directionality of the system. The usual descriptive data (number of alleys within each angle) can show the main trends of orientation within the cities' alleys, while the syntactic analysis can show the inner structure of the system, which is more important, and has a heavier weight than the usual streets.

6. MOSUL: A CASE STUDY

The city of Mosul was established as an Assyrian fortress, and Muslims controlled the city in 638 A.D. The city was re-designed according to Islamic instructions. Mosul creates its architectural and urban identity, which is characterized by the compact urban fabric with narrow and alleys and the prevalence of the inner courts as a response to climatic, social and cultural circumstances. Qibla direction in Mosul is 11 degrees from the south (clockwise), while summer sunrise is near 30 degrees from the east (counter clockwise).

It is also important to mention, that the fabric under investigation is the one usually referred to as 'the old city', since the modern city is much larger.

7. METHODS OF ANALYSIS

The syntactical approach as well as the visual analysis will be utilized here. The axial analysis, visual graph analysis (VGA) and agent analysis will be conducted to reach the goal. In addition, the whole city's street centers will be drawn to see towards which angle most streets are oriented.

Many studies show that the attributes provided by the axial analysis can give strong indicators to predict human movement through the urban spaces [16], while the VGA analyses the system visually, some studies argue that the VGA can predict human movement better than the axial analysis [17]. In Agent analysis, agents are released in the system and their movement recorded which simulates human movement [18].

8. RESULTS

Starting with the descriptive data, the number of alleys in the old fabric of Mosul was 2297 alleys. Categorizing them into (10 degrees) groups will give us 18 groups, since the angles calculated are from (0 degrees) to (180 degrees).

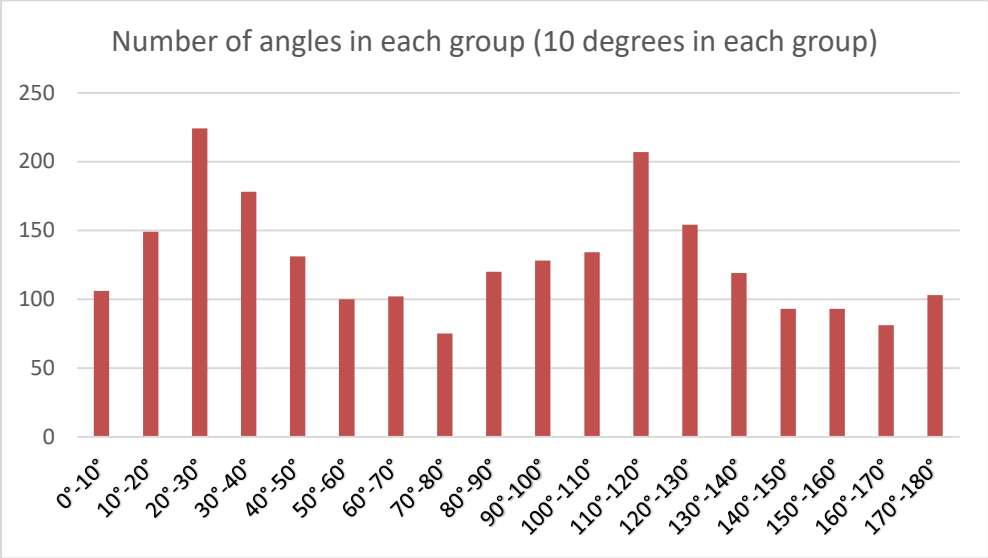

Fig 8: **The number of alleys within each angle**, [Study]

It is obvious from Fig 8 above that the categories with the highest number of alleys are around the (30 degrees) and (120) degrees angles, which are perpendicular, and propose a rectangular grid. The two second highest categories are the ones adjacent to the previous ones, and the (40 degrees) around the two mentioned angles (30°, 120°) control almost 30% of the whole number of alleys.

The number of alleys directed towards Qibla, (within the 8th category) was less than the average, 3.2% exactly. The number of alleys directed towards the east-west axis, was also not remarkable, since this direction received 4.5%. The same thing happened with the preferable environmental orientation in the city (the south), which was within two categories (9 and 10), and received an average of 5.4%.

The results above show that either the main factors affecting the orientation of the city (religious and environmental) are not affecting the orientation of the city, or they are affecting it but in a way different than the typical, direct, obvious way, and this is why a deeper approach has been followed, presented by the Space Syntax methodology.

If the agents' movement patterns are reviewed, it can be found that the agents are concentrated in the center of spaces, and the alleys that took the biggest share of agents were the central alleys and that are (connected to) or (lead to) the congregational mosque. In addition, by taking the streets with the highest values of agents' movements, and separating them from the rest, and putting them on the city's actual plan, figure (9) will appear. It is also possible to trace these streets, and find there centerlines, and by showing them on one straight line, It would be clear to see their distribution, and the angles by which they run.

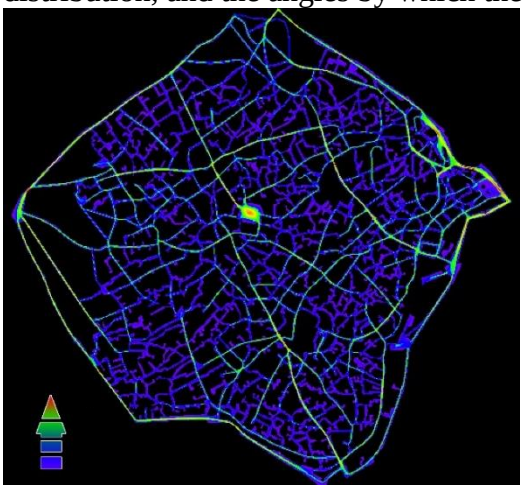

Fig 9: **The Agents' Analysis**, [Study].

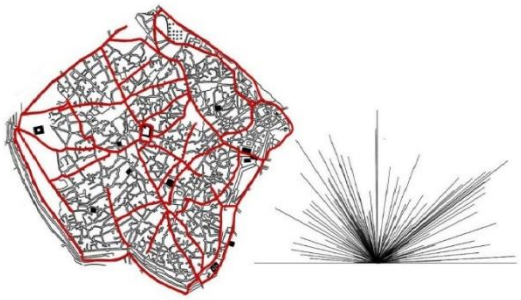

Fig 10: **The streets with the highest agents traces and their distributions**, [Study].

The VGA (fig 11), can show many of urban system's visual characteristics, and in this study, the concentration will be on a few particular attributes. The space with higher visual integration value means the space is more viewed. The high values of visual integration in the alleys and area close to the mosque proves the high density of visual activities in the area, leading to the fact that the congregational mosque and the area around it worked as a visual magnet for the city's habitants, directing their visual fields and dominating the city. Moreover, as done with the Agent analysis, it is possible to take the streets with the highest visual integration values and separate them, to see their orientations in respect with centerlines of the city's alleys (fig12).

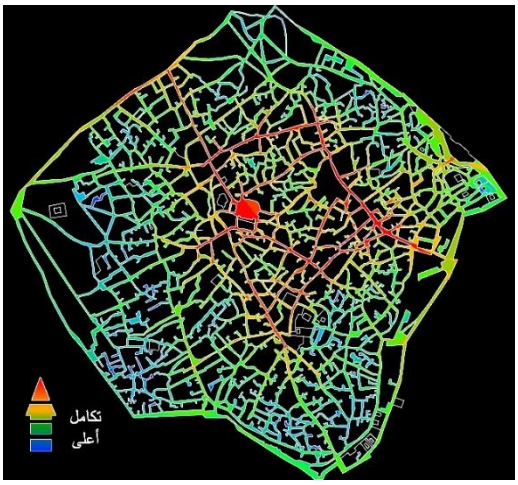

Fig 11: **The Visual Graph Analysis**, [Study].

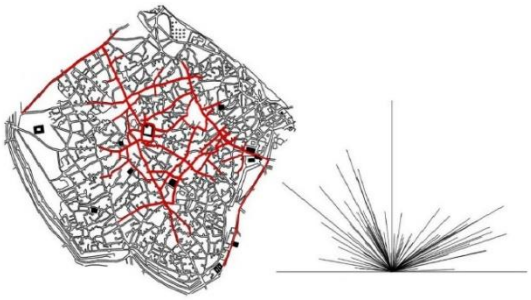

Fig 12: **The streets with the highest visual integration and their distributions**, [Study].

Axial Integration refers to (To-Movement), which means that the streets with the highest integration are the highest in attracting movement, which are represented in the city center and the alleys surrounding the congregational mosque too. The Integration diagram, along with the highest integrated alleys' directions, can be seen in fig (13) and fig (14).

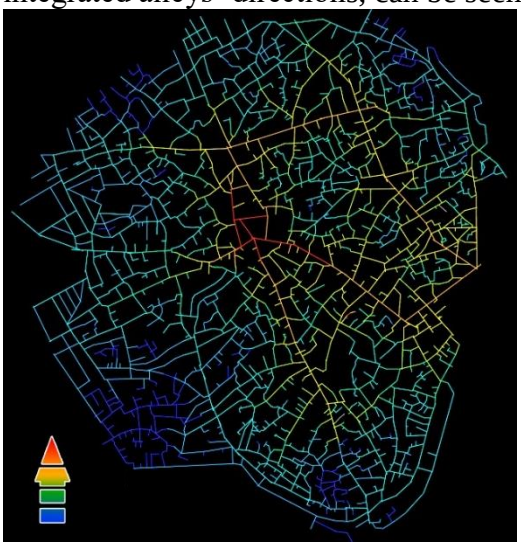

Fig 13: **The Axial Integration**, [Study].

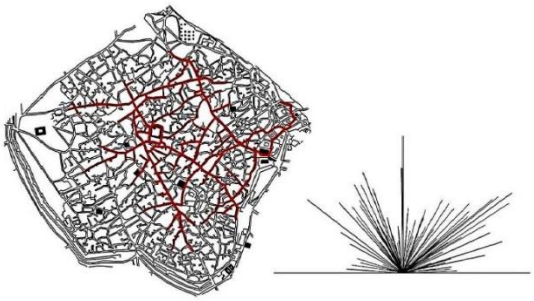

Fig 14: **The streets with the highest Axial Integration and their distributions**, [Study].

The choice diagram represents the (Through-Movement) which means that the alleys with highest choice represent the alleys with the biggest amount of human movement through them, and it is obviously clear, that the alleys with highest choice values tend to be directed with the summer sunrise angle, as seen in figures (15), (16).

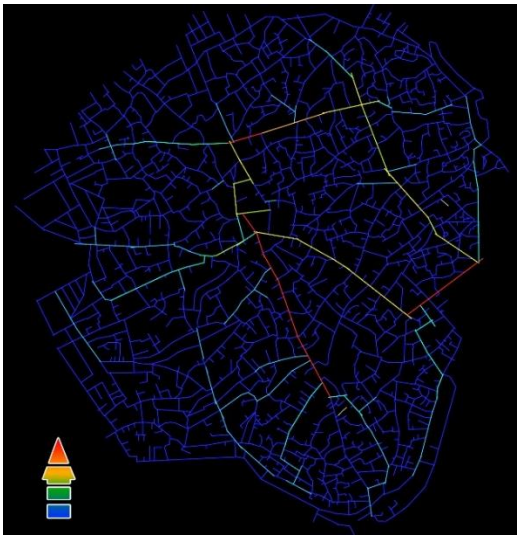

Fig 15: **The Axial Choice**, [Study].

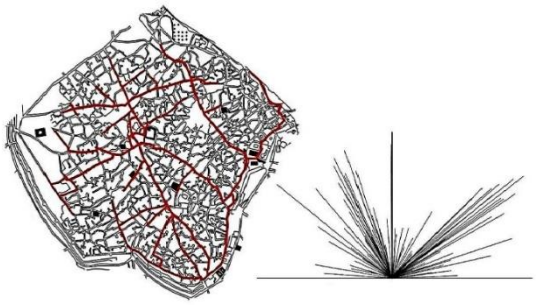

Fig 16: **The streets with the highest Axial Choice and their distributions**, [Study].

It is obvious from the diagrams above that the streets with highest values of axial integration and choice, tend to run within a specific angle, or close to it. The alleys with the highest visual integration and agents' movement present the same behavior.

Another aspect that affects the directionality of the urban fabric is the geographic factor, represented mainly be topography, and the river Tigris, the main source of water for the city's inhabitants. As for the river, its angle and its orientation according to the cities' main alleys can be easily noted and calculated, and their effect can be detected, as viewed in (fig 17).

In total, and by taking 10% of the highest values of each attribute, some of the primary results can be assured. 30.6% of the highest integrated streets are within the (40 degrees) around the (30-120) grid. Almost the same can be said for the choice values, with 32.6% of the highest choice values within the same angle. The streets with the highest visual integration, and highest agents' traces imply the same results, which proposes, that the city, organic and irregular it may look, is suggesting a hidden grid, directed towards a specific angle.

As for the topography; the city's topographical information was collected, and analyzed through a water shed modelling software named (WMS). The software analyzes the contour lines, and gives the pattern of the water flow, in a chart called water delineation chart as viewed in (fig 17). Then the city's urban fabric is matched with the water flow chart, and the alleys that were in accordance of the water lines, were identified, since the water flow and the topography of the land was the main factor determining their orientation. They can be seen as red dashed lines in (fig 18).

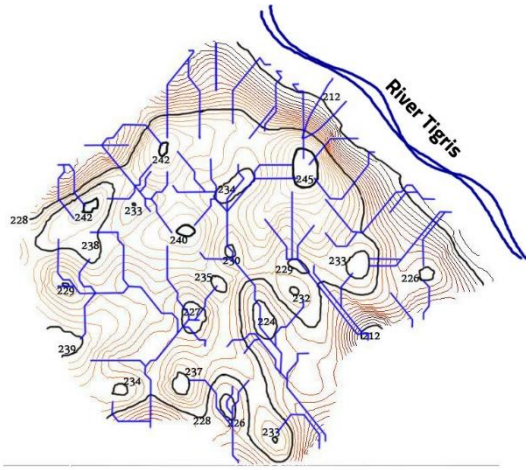

Fig 17: **Water delineation chart**, [Study].

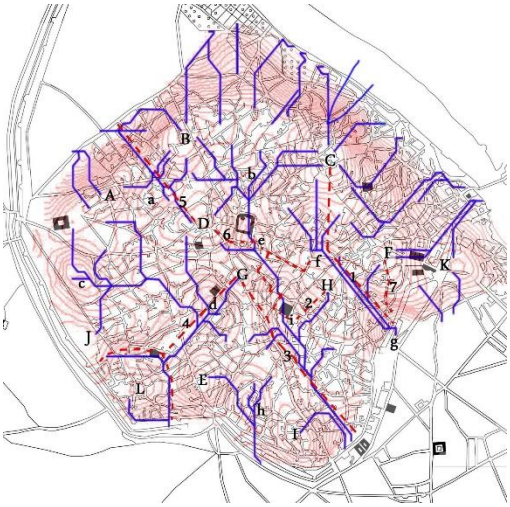

Fig 18: **The alleys affected mainly by the orientation of contour**, [Study].

9.CONCLUSIONS

Some important points can be concluded from the results above. The city's alleys are directed (visually) towards the congregational mosque, making it the city's visual structure's center. It is also noted that the streets directed towards Makkah are very little. However, the different Qibla directions theory, proposed by Dr. King can explain the results obtained here. Most of the important streets (syntactically) in the city are oriented within a 30-degree grid, proposing either a deliberate Islamic planning within this angle, or a pre-Islamic Assyrian grid showing its effect on the later Islamic planning. The geographical factor of topography had its effect also, by directing a few main streets, and affecting many more shorter alleys' direction, deforming the 30-degree grid. The other strong morphological formulator is the river Tigris, a natural linear barrier which is also close to the angle perpendicular to (30 degree) grid, proposing another reason of planning within such an orientation. It can be said, that many factors can affect the directionality of an urban fabric, and by studying them collectively, the organic urban pattern can be understood better.

The study would recommend more analysis of the same type, for more cases and more cities. With this approach, the organic, irregular form can be understood better. The study also can be a helpful guide for the urban designers, and urban design students, who would aim to mimic the organic fabric of traditional cities, since it concluded some regular trends within this irregular complex form.

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