ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

The Rules of Generative Code Module to Achieve New Approach of Urban Development

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Abstract **- Cities are complex systems that consist of physical element (Architecture, urban design, urban planning feature, etc.) and non-physical (social, culture, etc.). All these elements undergo different changes due to many factors such as the complexity of the city pattern and the development of the scientific theories.**
The research problem: The city lost its ability to have specific design method and procedure to preserve the city code. The research aims to determine a new design method to preserve the generative code of the city.
The generative urban design is a new procedure that dealing with the urban design complexity and replacing the traditional design methods to new one. The generative code identifies as a procedure that produces a design method to preserve the code of the city under the shade of the complexity, development of the cybernetic and technology, the procedure followed the generative process of the existing component of urban context. This generative process helps to encode the urban pattern of the city. The loss of the urban code leads the city losing several important characteristics such as the predictability, flexibility and adaptability. Thus, losing the growing of the city in control way.
The generative urban design is consisting of main generative design tools: formulation module, evaluation module, and generation module. These three main components represent the main tools to generate a new parameter rule of urban design, encode the city pattern and achieve urban design has its own documented data. The practical application will concern on the generative module that consist of (pattern language, induction pattern and shape grammar).
This paper will depend on analysis map tools CAD program and sketches to reach the goal of encode the city of Baghdad to diagnosis the problem and find the solutions.

Keywords - Generative code, Generative urban design, Shape grammar, Urban induction pattern, Urban pattern.

INTRODUCTION

The urban design process needs to flexibility and adaptability to reach a new methodology with supporting tool, this new methodology depended on the generative rules, urban pattern and shape grammar. All this procedure works together under the shade of the generative urban design procedure.
This paper is divided into several parts: The first part of the paper aims to define the generative urban design tools, the second part will explain the process of producing the generative rules, the final part clarifies the application of these rules on the case study by using analysis the pre-existing data, applying the shape grammar and UIP to codifying the urban pattern, and documented the code of the case study of Baghdad pattern.

1. Generative Urban Design

Every city has a code which is directly related with the pattern of the city, the generative urban design has a language to deal with the code of the city to increase the flexibility of the urban design. So, urban design code defines as “The purpose of the Design Guidelines is to provide a practical and flexible tool for assessing new development and redevelopment in the city. It is intended to provide a series of general, high-level urban design guidelines that apply to different forms of development - such as residential, commercial or industrial” (Ngô Kiên Thi, 2014, p. 2).

The generative urban design depends on the shape of the structure of the city (morphological characters) and its method of dealing with the complexity and the changes that faced the urban pattern. The generative urban design methods replace the traditional design method to new design methods dealing with the new complexity.

To commence with, the research will define the component of the generative urban design; it is consisting of main three parts: (Diagram 1).

a) Formulation module: is responsible for bases the analytical function on the knowledge and GIS base-the analytical function defined the detailed descriptions of programmer specification which represent the programming pattern and formalized as description grammar. (Mehaffy, 2008, p. 40).

These ideas are: noticing an issue in the urban context, afterward a solution is needed to solve the problem, make a clear pathway to find a solution, required technical tool to manage the context information interoperation of the issue, and coding of specification for the solution.

b) The evaluation module: is responsible for using the analytical tools and programs to determine the validation and assessment for the design. (Beirão, 2012, p 30).

c) The generation module: is responsible for providing the design with supporting tool that generate solutions for the design problems through following the encoded operation into customizable general design. (Beirão, 2012, p 30).

d) The generative code module: consist of many parts work together (the pattern language, the urban induction pattern, the shape grammar).

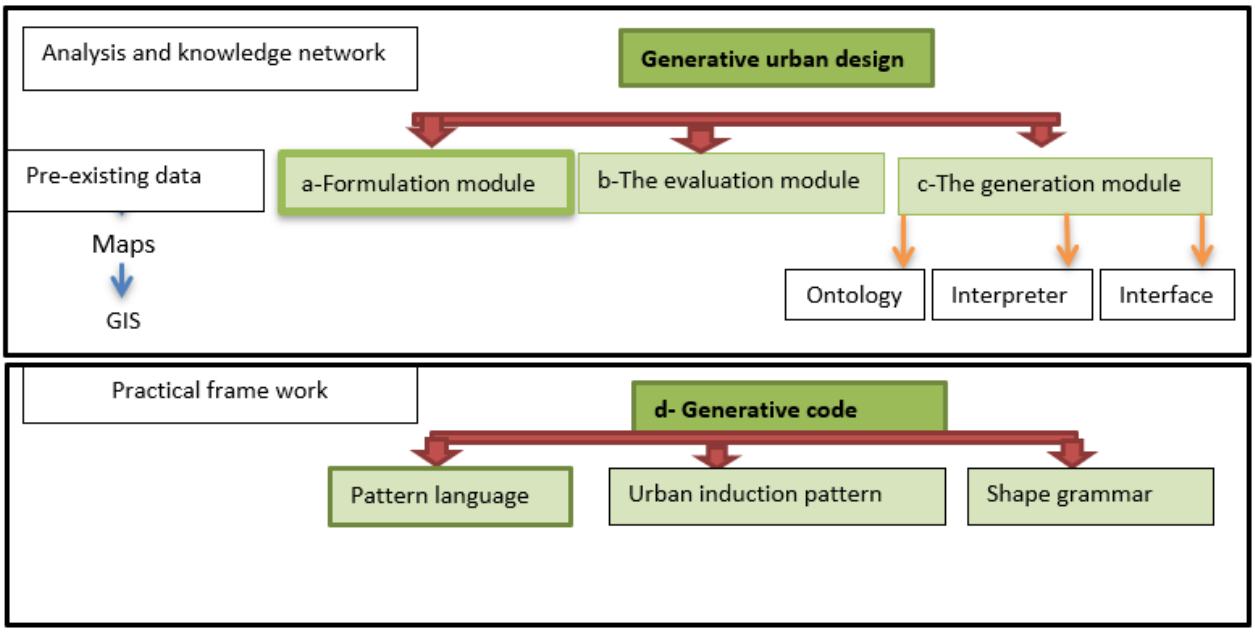

DIAGRAM 1
THE ONTOLOGY DESIGN SUPPORT

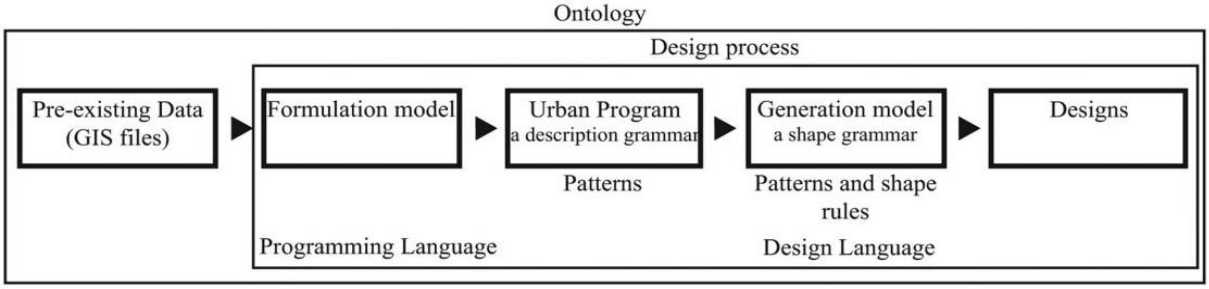

DIAGRAM 2
AN ONTOLOGY OF URBAN ENTITIES SUPPORTS COMMUNICATION THROUGHOUT THE DESIGN PROCESS (STOUFFS ET AL, 2008, P 930)

The generation urban design have a design language "The design language is an urban grammar that supports the generation process using design rules organized as patterns" (Stouffs et al, 2008, p 930). Diagram (2). Urban grammar is deferent from designer to another and the evolution process should be applied in all the five stages of the ontology structure see diagram2. "In the envisioned design system, urban design is the result of applying an urban grammar. The urban grammar is a set of urban patterns and shape rules that can be applied at four different scales or development phases, separately or together. (1) rules based on a territorial scale, through an analysis on existing morphologies, establishing the relevant features for the definition of the plan's structural geometries; (2) characterization of urban grids or city tissue, lays down the remaining features of the street structure; (3) urban unit characterization, determines the characteristics of the urban units, such as neighborhood, city blocks, and plots; and, (4) detailing of the urban space, which defines material aspects, ambiences and other details. An urban grammar encodes a design language and is able to generate urban design solutions within that language" (Stouffs et al, 2008, p 930).

GENERATIVE CODE MODULE

The generative urban design, design grammar, the generative procedure and language will prepare the urban pattern to reactive the code of the city, the generative code module consist of many parts work together (the pattern language, the urban induction pattern, and the shape grammar).

1. Pattern Language

Pattern language is considered one of main feature of generative code module, which clarifies it,in Alexander book, "A pattern language", the pattern language consists of 253 pattern and he clarified every project whether it large project or small project contains a group of patterns and these pattern represent the suitable entities in the project, eventually these entities will be classified and used to find the core of the solutions for the problems. (Alexander, 1977).

According to Christopher Alexander classification of pattern language, the research determines four important entities of urban design pattern, which is (Territorial landmarks, Basic geometry, urban units, Materiality) it's the way of dealing the urban grammar with the urban pattern to produce the method of encode and decode the city pattern. (Durte, 2011, p. 884)

The research assumes to find the benefits from the advantages of these steps of simulation to specify the suitable entities of pattern and collect the right information data that will be used in the formulation module in the generative code process.

2. The Urban Induction Pattern

After prepared all the information data from the analysis of pattern language and it is own entities to use it in the formulation module of generative process, the research moves to the second component of the generative code module which is the urban induction pattern.

The main goal of the urban generation process is to transform from the analytical process to the (encode process) by the set of rules that defining design procedure were initially called (Urban induction pattern) (Beirão. et al, 2009).

The UIP (urban induction pattern) is a digressive grammar that generate a recurrent and repeated design. This procedure is a combination of programing grammar and designing grammar. (Beirão. et al, 2009, p 575). The urban induction pattern finds it is rules in the pattern language; the main function of its components of the UIP is:

1. The programming grammar is representing the description grammar that classify the set of descriptions to complete and fulfill a specific design in specific urban context. (Beirão. et al, 2009, p 575).
2. The designing grammar is representing the shape grammar that encoding the design entities to reach the main rules which used to find solutions to the urban context problems by matching between the description grammar and programming grammar. (Beirão. et al, 2009, p 575).

The Urban induction pattern work parallel with the generative urban design which consist of (Formulation module, evaluation module and generation module) and it is a part of generative language, through the following main stages, (Diagram 3):

1. Stage one: collect the shapes from the ontology classification of the main elements that could found in the urban design environment.
2. Stage two: after select the right information from the ontology classification, the process moves toward how to provide the encoding process with the right parameter rules, in this stage the generative language take on the consideration the master plan to produce the primary shape grammar. This stage of the process works parallel with the interpreter and

interface which use to edit the urban grammar meaning and encourage the data requests outwards and receive, new data inputs see diagram 3.

As a result, the generative code deal with the encode language, and this procedure provided from UIP (urban induction pattern, which work with three main features (Formulation module, evaluation module and generation module).

The main aim of the city induction project "is a computer platform encompassing modules for formulating, generating and evaluating urban designs. In the present the research focused on the development of the generation module showing its main generative feature, the Urban Induction Pattern. UIPs are shape grammars encoding recurrent urban design procedures or design moves frequently used by urban designers." (Beirão et al, 2009, p 583).

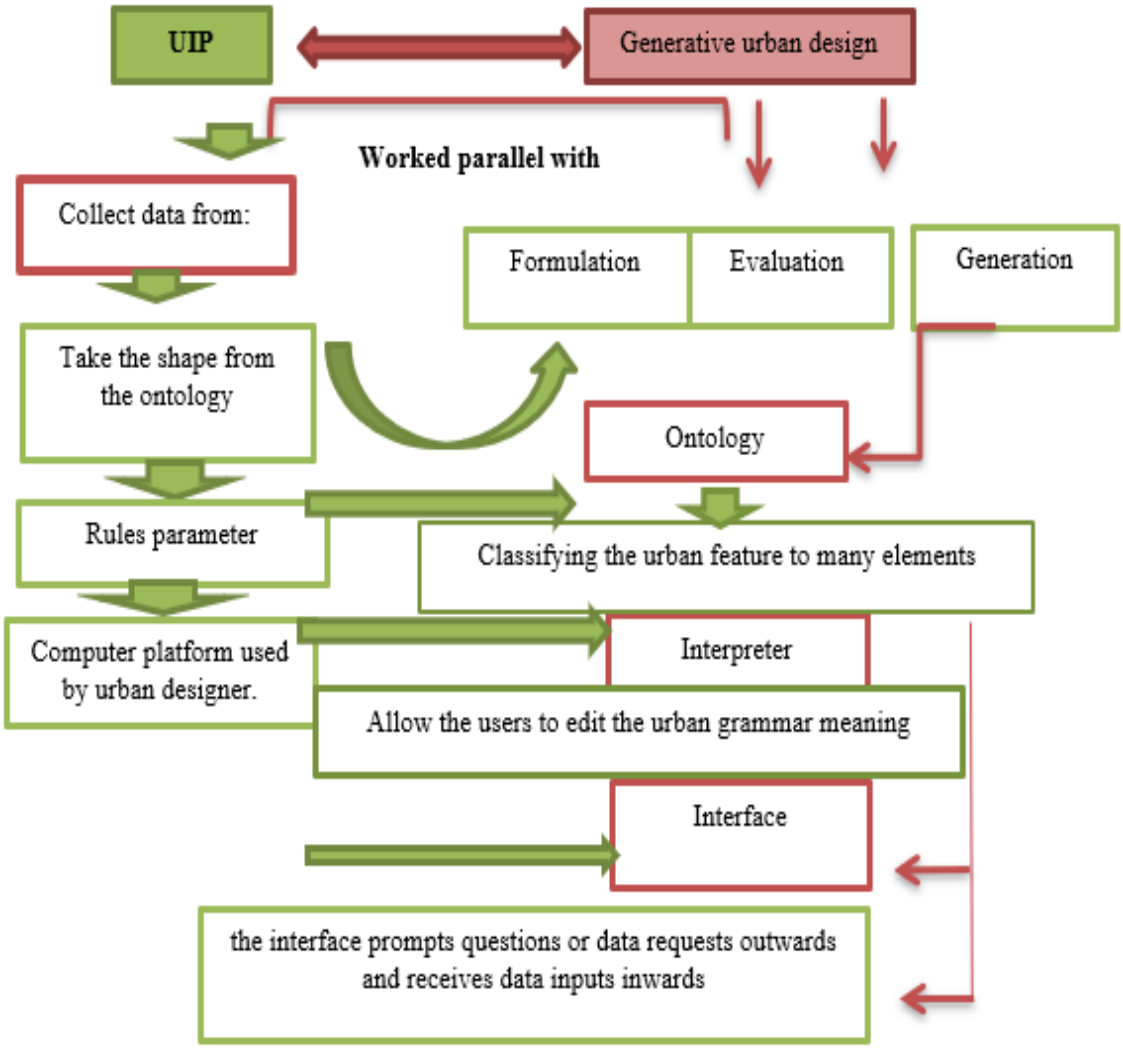

DIAGRAM 3
THE WORK PARALLEL BETWEEN THE UIP AND GENERATIVE URBAN DESIGN

3. Shape Grammar

The research chooses the shape grammar theory for codifying process. The shape grammar has been used frequently in architecture, but it was used in urban design field to produce the parameter rules to encode and decode the urban rules the main goal of using the shape grammar "is to create the basis for a system that could capture some feature of the existing

urban fabric and apply them in contemporary urban planning" (Rocha et al, 2007, p. 317), as well as choose the shape grammar corporation with the UIP to reach the goal of encode the main urban grammar.

RESEARCH METHODOLOGY

Research methodology will explain:

1. Specify the boundary of the case study.
2. Divided the urban pattern to many entities and specify the information module to each object.
3. After specify the level of the urban context, the research will use the procedure of (coding, encoding) to reach for the code of the city pattern.
4. The coding process, which is represent (generative code process, urban types, and pattern language). In this step the research will take the existing design and analysis it by specify the main guild line to lead the design development procedure.
5. The encoding process, which is representing (generative urban design which consist of formulation module, evaluation module and generation module), from this step the research began to formulate and evaluate the existing information which led to generate new design solutions.
6. All the above steps will give us the right information and description to move on towards the generative rules that's have the ability to encode and decode the city pattern.

1. Generative Code Rules and Urban Grammar Application

From the theoretical frame work of this research focuses on, the important city component from the procedure of generative code process, The main shape of the cortex from, the urban type and Alexander specification of the city (lattice and semi lattice), After specify the important component of the city and the urban type, the research move on towards the data and information that used in the practical frame work, Preparing all the necessary information from the following: A-Generative urban design will provide us with the analytical tools. B-The generative module, will provide us with the main practical tools to obtain the rules parameter.

From all the above, the research summarizes the main steps of the analytical approach (Table 1). The research will take the city of Baghdad as an example to the united between the shape grammar and UIP.

2. The City of Baghdad Code (Existence Plan Analysis)

The research worked on the urban plan of Baghdad and analyze the existing urban fabric.

1. Stage one: specify the boundary of the city of Baghdad and the wall (figure 1).
2. Stage two: focus on the Kharkh and Resafa region (figure 2).
3. Divided the urban pattern into many parts, blocks and neighbor (figure 3).
4. Select the small areas and shade it with the black color to see the deference between them (figure 3).
5. Recognize the most repeated shapes on the fabric and summarizes them (figure 3).

FIGURE 1
PLAN OF BAGHDAD DURING THE FLEX JOHNS PERIOD 1854. ACCORDING TO (VAN DE VEN, 2016, P 56)

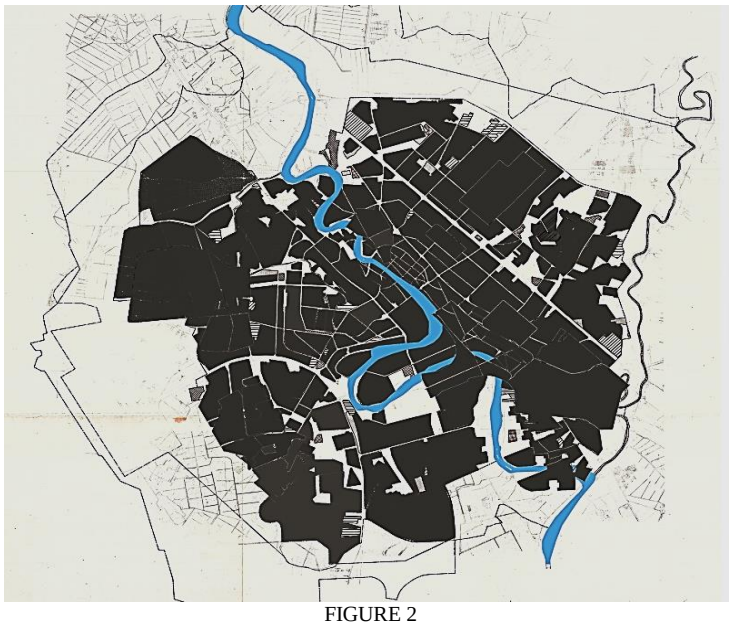

FIGURE 2
THE ANALYSIS OF THE EXISTING CITY OF BAGHDAD CODE 2021

3. Practical Application for the United of the UIP (Urban Induction Pattern) with the Shape Grammar

The union between the UIP and shape grammar will explain as a practical way of an experience of Baghdad city pattern. The research will analyze the urban design of Baghdad according to Coding indicators (Table 1).

1-Phase one: Generative code process, this stage represents the determining of the main problem of Baghdad which represent the lacking of the process that guild the growing and redevelopment of the city.
2-Phase two: Urban type: the urban type of the city is the most important stage in coding process because it will help to specify the urban type of the city and urban guild line that will support the future change and growing.

TABLE 1
THEORETICAL FRAMEWORK INDICATORS OF BAGHDAD

Theoretical frame work	**Relation**	**Method**	**Indicators**
Generative code process	Baghdad has undergone many studies and development plans, but the research cannot considered this stages as a generative process	The urban comprehensive plans of Baghdad lacking the integration between its parts.	The entire comprehensive plans target was how to improve and solve the problems of Baghdad but no one of them tried to complete what the previous work ended with.
Urban type	Before poulservice urban plan, Baghdad was an organic fabric, poulservice starting to add anew axis and new blocks, but that's new add wasn't connected to each other.	Poulservice new addition was inserted without determining the caradous and Decamoanous axis.	Baghdad grid considered as a poor connected grid.
Pattern language	The shape of the old fabric of Baghdad was organic grid.	Through many stages since 1973 the city began to move from semi lattice to lattice system.	Pattern language indicators deepened on: 1-territoral land mark. Specify the relevant feature of the city boundary. 2-Basic geometry: Recognize the geometrical and grids. 3-urban unite: The neighborhood feature will constrain the next operation on the urban development. 4-materiality: Define the common material on the context

4. Apply Baghdad City to the Practical Frame Work

The research will apply the practical indicators on the urban fabric of Baghdad to encoding the existence plan of the city, according to Encoding indicators (Table 2).

1. Phase one: in this stage the research will determine the inner Baghdad and suburb zone, poulservice aim to reduce the pressure on the city of Baghdad.
2. Phase two: the aim was transforming the city from the center to the suburb.
3. Phase three: this step represents the target of the practical frame work, the research divided the city according to its pattern entities, adding axes and adding block to reach for the initial shape grammar that used in the future redevelopment.

TABLE 2
PRACTICAL FRAME WORK OF THE CITY OF BAGHDAD

Encoding

Phase	Practical frame work	Relation	Method	Indicators
	Formulation module	Collect the information and analysis them.	Polservice determined:- greater Baghdad • Inner Baghdad. • Baghdad suburb zone.	This division to the city prepared to decrease the pressure on the current city center.
	Evolution module	Evaluate the collect information.	Polservice create a new proposal that contains a establishment space situated between khulafa street to the west, king Ghazi to the east, Al-Wathbah street to the north.	This new division create a new center. • Central business district. • The new proposal provides a new ring road, started from the north side 14th july road and the Muhammed Qassim freeway.
Phase 2	Ontology	The purpose was reducing the pressure on the city center.	The method was creating a new ring road and new boundary for the city.	Classify the urban feature to many elements: • The boundary of the city. • Ring roads • Gates • CBD central business district • Neighborhood.
Generation module	Interpreter	Polservice interpret his purpose by:- create specific criteria and regulation to preserve the identity of the old of Baghdad.	Polservice was the only studies and comprehensive plan that tried to work with regulation.	This regulation was the only way to the future rule parameter .

	interface	The first purpose of Polservice was find the integration between the old and new parts of Baghdad.	The great population in the old quarter was the bigger problems that the context faced it.	To find the inappropriate solution, the proposal should find the integration and union of all parts which was impossible with Baghdad.
Phase 3	Pattern language	Pattern entities	Specify the grid of pattern, the streets, the waterline, the blocks, neighborhoods, plots, open spaces ...etc.	Decoding the pattern entities to P(1)independent region , P(16) web of public transportation P(49) looped local roads P(52) network of paths and cars P(54) roads crossing
Generation code module	UIP	Adding axis	Polservice comprehensive plan didn't specify main axis as caradous and the second axis as decomonous.	Baghdad didn't have a discursive grammar that generate recurrent design procedure.
		Adding block	The new blocks that Polservice add was madenat Al-sader.	The result from the addition was intermingled with the old fabric and unfair.
	Shape grammar	In all the level of studies and analysis that work on Baghdad didn't resort to the shape grammar.	That prevented the generate process	The absence of the shape grammar from all the comprehensive plans that lead to lack the integration between all the plans and prevent the future generated process.

Encoding

5. The Result of Baghdad City Code

The research divided Baghdad fabric into four sections, then divided each section to many plots and shaded the shapes that repeated in the context, through this phase the research will reach to the rules parameter that used in the future urban redevelopment.

The research results appear in (figure 3) (Table 1) (Table 2), where the grid iron that entered to the organic shapes of pattern of the city of Baghdad produced many different shapes. The first urban fabric produced (semi-triangle shape and rectangle shape). The second urban fabric produced (rectangle, Square and superimposed shapes). The third urban fabric produced (rectangle, triangle and superimposed shape) the fourth urban fabric produced (triangle shape).

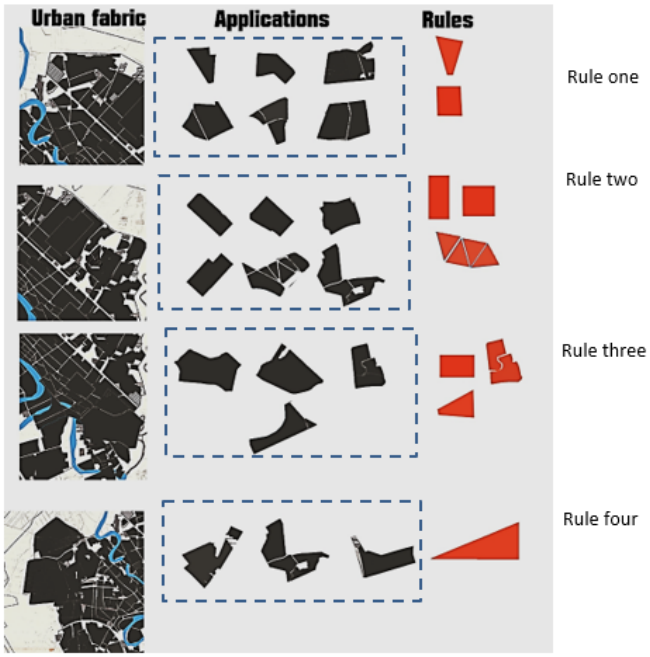

FIGURE 3
THE URBAN CODE OF BAGHDAD ANALYSIS

CONCLUSIONS

1. Shape grammars and patterns contain the algorithmic qualities needed to develop formal generative systems for exploring urban design solutions.
2. The shape grammar work in apparel line with Alexander pattern language and that is help the designer in the analysis process and then in application process.
3. The research recommends to use the old code and try to decode the city again through the development urban plans to preserve the rest of the city connection.
4. The benefits of using the shape grammar as a main generative tool by specify the site plan of the specific region of the case study.
5. The research takes the existing plan of Baghdad 2020 and apply the coding and encoding process on its pattern to reach for specific parameter rules.
6. The research divided the pattern into many shapes and shaded the common shape to specify the most repeated shape.
7. The challenge was how to engage the old organic fabric with the new grid fabric that's lead to disconnected many parts of the city.
8. The old fabric of the city of Baghdad was organic, but the main problem was beginning in (1914-1956) when opened four main streets in Baghdad (Al rasheed street, Al-Kholafa street, Al shekh omar street and Al-Khefah street) these four streets led to disruptive the urban fabric bonds. (Diagnoses the problem).
9. All the result from all the application of the (shape grammar and UIP) analysis clarified that's Baghdad city doesn't have a specific code and many regions began to be isolated from the other parts.

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