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Generative Plan Recommendation for Diyarbakir Traditional L Plan Type Houses

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Abstract
Architectural designs with an orientation towards nature not only distract the designer from randomness, but also make him/her realize his/her responsibility towards nature. At the same time, designs in harmony with nature provide gains for nature and reduce the damage caused by the building sector to the environment. Although today's technological developments have provided many advantages, they have also led to an increase in structures disconnected from nature. In this respect, the study emphasizes that the principles obtained as a result of the structural analysis of Diyarbakır traditional houses should be proposed as a model for today's contemporary housing production.
In this study; the generative design approach, which is formed with the contribution of computational sciences, is examined. Also; the use of Lindenmayer Systems, a generative algorithm, in the architectural design process and its relationship with sustainability is discussed.In the study, a model proposal is prepared based on the analysis of 14 L-plan type traditional Diyarbakır houses.The examined plan typologies were recoded with the Lindenmayer program based on the building orientation parameter. Through the data obtained, ideal housing typologies that are compatible with the climate and traditional architecture of Diyarbakır city and can appeal to different users have been produced.
Keywords: L-Systems, traditional housing, productive design, computational design, Diyarbakır traditional architecture

1. INTRODUCTION
Lorem All the structures built by human beings to meet their spatial needs have been elements that affect the entire ecosystem, primarily the immediate environment, both in the construction and use process. Construction adventure, which initially started to meet the need for shelter, has become one of the main factors that disrupt the balance of nature over time. Therefore, the architectural design process continues its evolution by gaining new orientations every day; it renews itself according to new design approaches that gain importance. With the industrial revolution, the destruction of nature caused by mankind has become a serious threat to living standards, and thus, in the 21st century, ecological approaches in architecture and design ideas with an orientation toward nature have gained value.

With the development of technology, different digital methods have been used to perform architectural shaping. Nowadays, the forms of inspiration/learning/adaptation and/or application from nature and how they can be used in different fields of knowledge/technology have started to be systematically discussed. In this study, the reflections of nature-human interaction in architecture are exemplified and the process of inspiration from nature is analyzed using L-systems (Lindenmayer systems).

In this context, with computational theory and computational models, the environment is re-evaluated, factor-system relationships are explored and new knowledge is acquired in this direction.

Today, buildings that lack the cultural, economic and social status of the regions in which they are located cause many discussions in the fields of architecture, urbanism and engineering. L-systems, one of the productive systems that have emerged with the development of technology, enable the design of structures that are formally and structurally compatible with nature.

Lindenmayer systems (L-systems) is designed as a mathematical theory of plant development. L-systems allow the designer to conduct experimental studies in a short period of time by understanding and simplifying the nature the form. Lindenmayer systems, which are formed by the study of plant morphologies and growth processes, are in a construct that can be reflected in the form with rule-based and inductive approaches. In this case, it can be said that computational theory and the act of learning from nature are realized through a new interface. Computational and numerical thinking plays a structural role in classifying, constructing and systematizing data from the environment (Prusinkiewics & Lindenmayer, 1996).

Today, the problem of the incompatible construction with nature is seen as a serious threat to sustainability and the ecological cycle. Ultimately, it has been concluded that it is necessary to produce fast solutions to architectural problems and to design buildings in harmony with nature by using developing computer technology. In this respect, the main purpose of the study is to investigate the effect of generative systems on the design approach process of buildings in practice, and to gain a different perspective due to the inclusion of computational design approach in this process with Lindenmayer systems. Although it is aimed to design inspired by nature, more importantly, it is aimed to reveal the principles of this order in nature and to use it. In addition, in the scientific studies conducted so far, no study has been found to determine whether traditional houses are in harmony with nature with computer-aided generative systems. This constitutes the importance of this study.

The Sur İçi region of Diyarbakır province was chosen as the study area. In this study, the architectural language of L-plan type Diyarbakır traditional houses was analyzed using Lindenmayer systems.

For the analysis of local residential architecture, 14 L-plan type Diyarbakır traditional houses located in Diyarbakır Sur İçi was considered. The reason for choosing this field is the that houses reflecting the traditional architecture of Diyarbakır are concentrated on this region. In the prepared study; 14 L-plan type traditional Diyarbakır houses were recoded using the Lindenmayer system program. In this analysis; the plan typologies examined were recoded with the Lindenmayer program based on the Buildingorientation parameter. In the analysis made here, it has been determined that traditional houses are mostly inspired by nature and show a development in harmony with nature. In this direction, with reference to the design principles of traditional houses in harmony with nature, a proposal has been made for the production of L-plan type contemporary houses that are planned to be built in Diyarbakır.

2. MATERIAL AND METHOD

In this part of the study, the methodology used is explained in detail. First of all, the relationship between nature and design is discussed. In the next section, the development of the concept of generative systems and their applications in architecture is analyzed. Lindenmayer systems, a rule-based, plant growth and development process-oriented systems, are investigated as productive design tools and their use in architectural design is examined. Afterwards, traditional Diyarbakır houses were analyzed and a comprehensive literature review was conducted in terms of architecture. In this study, the plan typology analysis of 14 L-plan type Diyarbakır traditional houses selected in the Diyarbakır Walled City area was analyzed using Lindenmayer systems. The basement, ground and ground + 1 floor typologies of the houses were branched separately with Lindenmayer systems. All the data obtained were tabulated separately and the facade orientations of the houses and the number of branches were calculated as percentages.

For this purpose, re-branching of traditional houses;
- The courtyard is the main evaluation criterion, with reference to the façade orientation of the spaces facing the courtyard,
- If there is no space oriented toward the courtyard, if the space to be branched is in connection with another space, according to the space it is in connection with,
- For spaces that are not connected to the courtyard but are connected to both the facade and another space, the facade is primarily used as a reference for branching,
- For courtyards and spaces without exterior connection, the facade orientation of the connected space is taken as a reference for branching,
- for both the courtyard and the space that is in connection with another space, with the courtyard as the first preference in the branching orientation,
- for spaces with courtyard and façade connections, with the courtyard as the first choice for orientation,
- the entrance to the courtyard is not considered a space and is not included in the branching,
- the transition interval between spaces is accepted as a branching criterion if it is connected to the courtyard.
- The staircase element is excluded from the branching as a rule,
- In plan and warehouses wc, warehouses that very little light and do not have any facade orientation, are because the door openings open to the courtyard, that is, to the outside environment, which is the onloption to be preferred,
- If the gezemek is located independently as an architectural space, the facade orientation of the gezemek is accepted as the branching direction, but if the gezemek is connected to another space, the orientation of the space is excluded from the branching as the main criterion.

In the last stage, Lindenmayer systems, which adopt a design approach focused on the plant growth and development process, were used to create a model that reflects an example of construction in harmony with nature. In this respect, the data of the traditional buildings analyzed through Lindenmayer systems, which are in harmony with nature, were determined as the basic principle in the design and solutions were tried to be proposed for the current construction.

3. IMPACT OF NATURE ON DESIGN

Nature has attracted people's attention and been a source of inspiration since the first time it was considered in terms of architectural design. In this direction, human beings have been researching nature since ancient times; they have interpreted the information they have obtained and used it in architectural designs by imitating or using an analogical approach. In this respect, the approach of human beings, who require shelter or space, to nature has formed the main character of architecture. In other words, the main factor determining the formation of space has been the relationship between humans and nature (Zeytün, 2014).

Recently, with the rapid development of technology, designers have taken nature beyond imitation. At the last point reached in today's architecture, with the development of technologies, it has gained importance that the design process should be designed rather than result-oriented design.

In the design process, the re-exploration of natural and artificial processes, computer-based tools and new constructs obtained through computational theory support interactive information exchange by acting as an interface between natural and artificial organizations (Erdoğan & Sorguç, 2011).

Cellular automation and L-systems are considered as the first attempts to model the complexity of nature with algorithmic processes and to apply this model to artificial systems. L-systems, a variant of cellular automation, were developed to model the growth and development process of plants (Rocker, 2006). In this direction, human beings, who first gained experiences by observing nature, are now using nature as a model for research and studies. In this study, the effect of human-nature relationship on architectural design has been analyzed. At the same time, it tries to reveal whether the built environment is in harmony with nature through L-systems and proposes a model in light of the data obtained.

4. COMPUTATIONAL DESIGN AND GENERATIVE SYSTEMS

Computational approaches to design have emerged recently and have rapidly become popular among architects and other designers. Computational thinking can be defined as an algorithmic way of thinking based on mathematical and logical operations and processes in problem solving.

The computational design approach expresses a performance-based architectural understanding consisting of parameters. Parameters represent the behavior of the form to be created, that is, its performance. The concept of performance here is that the object to be designed; It expresses a wide area from the scale of structure and space to materials and elements, from the visual performance of the space to its environmental and functional performance.

Generative design is defined as a design strategy in which the designer does not interact directly with materials and products during the design process, but differs from other design approaches through a kind of generative system. Generative architectural design refers to a specific approach to design problems in architecture and reflects the characteristic problems of design in general (Herr, 2002). Computer-aided generative design aims to use computational sciences as variation-generating systems to generate large solution sets, to obtain unexpected alternatives, and to facilitate the exploration of alternative solutions in design.

There are different generative system approaches in architecture for planning and design purposes. These approaches are discussed under the titles of Form Grammars, Fractals, L-Systems, Genetic Algorithms, Evolutionary Design, Cellular Automation, Self-Organization, Swarm Intelligence and Multiple Agents (Kotnik, 2010). In which processes of design these approaches can be used effectively or can guide the designer, contribute as a tool, an environment, a consultant or a partner is an important issue to be considered in the context of computational design. Within the scope of the study, L-systems, a nature-inspired approach, are proposed as a model by creating different new plan typologies with an attitude similar to the growth processes of plants.

4.1. LINDENMAYER SYSTEMS AND THEIR PROPERTIES

Lindenmayer systems (L-systems) are a rewriting and visualization method developed by Aristid Lindenmayer in 1968 to simulate the growth of multicellular organisms and subsequently used by many biologists and computer theorists (Prusinkiewics & Lindenmayer, 1996). It is a mathematically abstract model of plant growth. Simulation and visualization techniques of L-systems are effective in studying plant development processes and understanding their topological and structural formation. It is a self-organizing and self-repeating system (Hensel, 2006). L-systems differ from design grammars in that they operate on sequences that are symbolic representations of design rather than the design itself (Parish & Muller, 2001).

This approach, which is generally used in the production of organic forms and fractals such as plants and textures, has limited applications in design, but is used in the derivation of transportation networks in urban and regional planning. Today, the main idea of the L-system is examined in the discipline of architecture in terms of producing designs suitable for the ecology of the environment with the help of algorithms. While it was first used in the development of simple plants, it was latter used to investigate the development of advanced plants and plant organs. L-systems
- an alphabet of letters to be used for typesetting,
- production rules that expand each letter into a larger string of letters,
- It consists of an initial string (belit) to start production and a mechanism to translate the produced strings into geometric structures (turtle graphics).

L-systems are a set of production rules that are repeated by rewriting strings. Rewriting systems create complex objects by continuously adding new parts to the initial simple object using rewriting rules. An example of this is the geometric representation called the Koch Snowflake Curve (Prusinkiewics & Lindenmayer, 1996). The Koch curve was introduced by Helge von Koch in 1906. To create this structure, a line is first drawn and divided into three equal parts. Then the line segment in the middle is replaced by the other two sides of the equilateral triangle formed on the same line segment. In the next step, the previous process is repeated on the four obtained line segments. This repetition process can be continued indefinitely (O'Connor & Robertson, 2000) . The production of the Koch Curve is given in Figure 1.

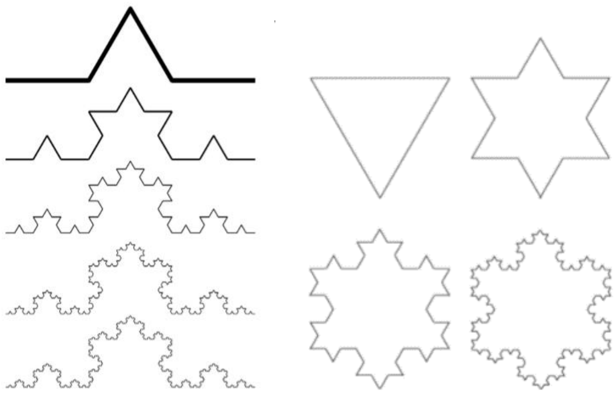


Figure 1 Generation of the ‘Koch Curve’ (Prusinkiewicz &Lindenmayer, 1996)

L-systems use 2 basic algorithms to create and visualize the growth process. The generative algorithm is the first of these subsystems. This algorithm, in which the array rewrite method is used, is simply the development of an initial state consisting of a limited alphabet, in accordance with certain rules. The second subsystem performs the visualization of the defined sequence. Visualization, usually performed using "turtle graphics", is based on projecting each symbol defined in the character string onto the chart. There are 4 different types of L-systems in themselves. These:
DOL-systems: The simplest of the L-systems are the DOL-systems, which are at the same time causalist (deterministic) and context-insensitive. These systems have been used to uncover the cellular growth systems of algae. The repetitive nature of DOL-systems leads to self-similarity (Prusinkiewicz &Lindenmayer, 1996).

Branching Structures: According to the rules shown in DOL-systems, the turtle builds its symbol strings through a series of line segments. There is no branching formation here yet. However, since most plant species are composed of branching structures, the mathematical descriptions required to model tree-like structures are made through branching L-systems (Prusinkiewicz &Lindenmayer, 1996).

Context sensitive L-systems : While production in L-systems is context-independent, the production practice can also depend on the context of the previous one.

Probabilistic (Stochastic) L-systems : Stochastic L-systems are systems that fall between alternative production rules. Stochastic L-systems are used to obtain variation between models according to probability. In L-systems the same development step is always produced. This leads to the production of the same string and all plants produced by the L-system are identical. To avoid this effect, it is necessary to produce variations of a plant that will maintain its general characteristics but change its details (Prusinkiewicz &Lindenmayer, 1996).

4.1.1. Reinterpreting Strings with Turtle Graphs

Many geometrically different interpretations have been introduced to model more complex plants with L-systems. In general, "turtle graphics" are used as a graphical representation of L-systems. The turtle concept is based on a small mechanical robot built by scientist Grey Walter in 1950 (‘csulb’, t.y). The so-called "turtle graphics" method works in the form of specific vectorial definitions of codes and an agent with defined instructions that executes the characters in the array (Prusinkiewicz &Lindenmayer, 1996).

Character sequences are divided into 2 main subgroups within the definition of the algorithm. Visualization characters define the shapes formed by the traces of the agents movement on the screen in vectorial form. By defining the coordinates of vector points, 2D and 3D shapes can be obtained. Control characters, on the other hand, contain the main control definitions for the control of the agent's movement such as advancing, rotating and branching (Cestel,2008).
In the program "Turtle graphics";
- ɑ is the angle defining the orientation of the turtle,
- d step size,
- δ are symbols used to represent the amount of angle increment. Through these symbols the turtle can respond to commands. The main turtle commands are as follows:
F: step forward leaving a trace of d
f: stepping forward without leaving as many traces as d
+: Turn left by angle δ
-: Defined as rotation to the right by an angle δ.

Turtle graphs can be used to represent L systems with different belts. Shape a in Figure 2.16 is called the squared Koch Island, while the shape b describes a variation of the Koch curve that uses right angles . The representation of the ‘Koch Island Curve’ depending on the number of recursions is given in Figure 2.

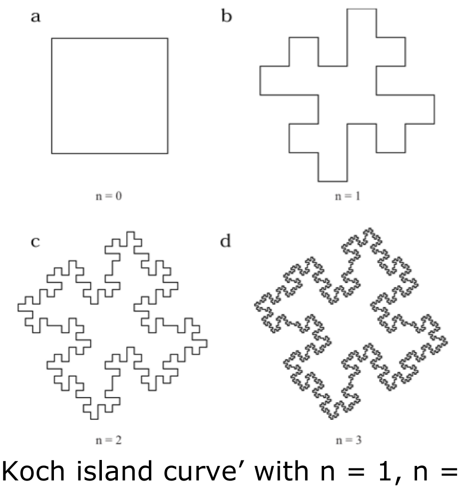


Figure 2 Illustration of the ‘Koch island curve’ with n = 1, n = 2, n = 3, n = 4 recursions (Prusinkiewicz & Lindenmayer, 1996).

The derivation features of Lindenmayer systems in the second dimension can be transferred to the third dimension by providing the necessary parameters. Similar control parameters on the X and Y axis are applied on the Z axis, allowing movement in a 3D plane. Thus, it is possible to create volumes whose boundaries are determined by the line segments formed by L systems in space. An example of the use of these symbols is the three-dimensional Hilbert Cube (Aldemir,2014). The three-dimensional 'Hilbert Cube' representation is given in Figure 3.

Figure 3 Hilbert cube (Prusinkiewicz & Lindenmayer, 1996).

In this respect, with Lindenmayer systems, it is possible to visualize and create complex forms with the simultaneous application of each rule in the repetition and loops of simple geometries.

4.1.2. Use of Lindenmayer Systems in Architectural Design

Lindenmayer Systems, which are generally used in the production of organic forms such as plants and tissues, repetitive patterns and fractals, in the field of design; It are preferred in applications such as creating Buildingforms, determining facade production, urban planning and transportation networks, and analyzing and interpreting historical buildings. While algorithmic definitions of complex geometric forms require advanced knowledge of geometry, L-systems facilitate the definitions of shapes with their general structure (Hansmeyer, 2003). The algorithmic basis of L-systems can contribute to the architect, as a designer, to explore different forms and to follow the development of the form at every step by creating the forms with a fundamentally evolving approach. L-systems can enable the designer to increase his productivity by evoking new forms. Composition of forms with character strings facilitates data exchange with other programs and enables them to be adapted to other programs by user groups from different disciplines and knowledge levels (Cestel,2008).

4.2. DIYARBAKIR TRADITIONAL HOUSES AND ARCHITECTURAL FEATURES

Diyarbakır is a province located in the transition zone between Mesopotamian and Anatolian civilizations in the Southeastern Anatolia Region of Turkey.

Diyarbakır is considered to be one of the most important cities that reflects the architectural values left by the great civilizations that dominated here with its castle, inner castle, various monumental structures symbolizing the development of urban history, traditional housing texture and the architectural values left by the great civilizations that dominated here.

Elements such as walls, inns, baths, fountains, mosques, churches, masjids, mansions and traditional houses in the traditional settlement texture of the city of Diyarbakır have an important place in the formation of Diyarbakır city architecture . Diyarbakır traditional houses are given in Figure 4.

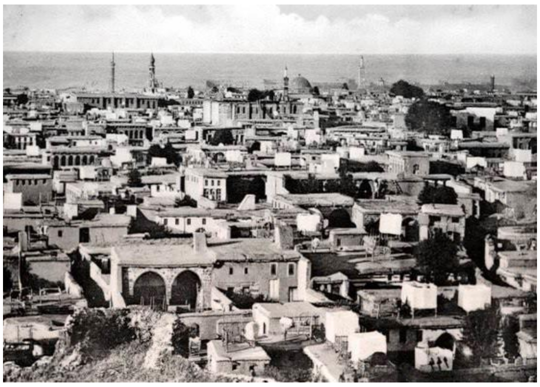


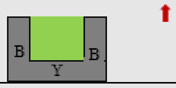
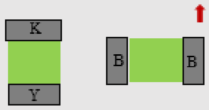
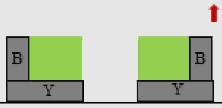
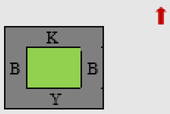
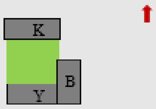
Figure 4 Diyarbakır houses of the 1910s (‘eskiturkiye’,1910)

Traditional houses, which are one of the most important Buildinggroups of the Diyarbakır Walled City region, are facing inwards rather than outwards to the courtyard depending on the seasonal factors of benefiting from or avoiding the sun.

In the architectural shaping of Diyarbakır traditional houses;
- topographical features
- socio-cultural factors
- material
- walls were effective.
- climatic factors.

The climate factor, which is effective in the architectural shaping of Diyarbakır's traditional houses, necessitated the planning of houses with courtyards and iwans. The number of iwans, the size of the courtyard and the parcel size of the Buildingvary according to the wealth of the owner. Diyarbakır traditional houses consist of a rectangular, square or trapezoidal courtyard and one, two, three or four Buildingmasses surrounding it. Each mass arranged around the courtyard has different characteristics depending on its orientation. The houses generally consist of a basement, ground floor and ground+1 floor. There are usually storage areas in the basement. On the ground floor, there usually rooms, iwan and service areas. On the ground+1 floor, there are rooms, an iwan and a bathroom unit. The location and shape of the courtyard in Diyarbakır traditional houses have led to the formation of different plan typologies. In addition, the placement of spaces around the courtyard according to the seasons has led to the formation of different plan types. The courtyard architectural element on the ground floor is the center of the house. Traditional Diyarbakır houses have U, I, L, Inner courtyard plan typology according to the courtyard and the Buildingwings around it.Typologies of traditional Diyarbakir houses given in Table 1.

Table 1 Location of seasonal masses in Diyarbakır traditional houses

Plan types	Location of spaces around the courtyard	Description
U type plan		The courtyard is surrounded by spaces on three sides. One wall of the courtyard faces the street.
I type plan		There are spaces on two opposite sides of the courtyard. The courtyard is located in the center. This type of plan is also called the karnıyarık plan type.
L type plan		The two adjacent sides of the courtyard are surrounded by spaces. The remaining areas are used as courtyards.
Inner courtyard plan type		The quadrangle of the courtyard is surrounded by spaces. All spaces belonging to the summer, winter and spring sections are available in this plan type.
Intermediate plan type		It is a plan type in which the courtyard is surrounded by spaces on three sides. Two sides of the courtyard are generally open and face the neighboring building or street.
K: Winter spaces Y: Summer spaces B: Spring spaces : Spaces Courtyard : North direction		

In addition, as in every region, there are main spaces that constitute the Buildingcharacter of Diyarbakır traditional houses and the region-specific Buildingcharacter. These;
- courtyard,
- iwan,
- rooms,
- service parts,
- are space-specific elements.

In Diyarbakır traditional houses, facades are shaped according to the direction they are located and can be different from each other. This difference is formed by the size, size, number and the shape of the openings on the facades. It is also possible to see the effect of the concept of privacy and economic status on the facades. Because of the effect of privacy, a plan typology has been formed with an inward orientation rather than an outward orientation. In this respect, openings increase on the interior facades facing the courtyard and ornaments are made more intensely. The economic status of the family enabled the ornamental details on the facades to increase and the materials used to be processed with fine quality. The facades of Diyarbakır traditional houses are given in Figure 5.


Alipaşa District — Savaş District
Dabanoğlu District — Dabanoğlu District

Figure 5 Facades in Diyarbakır traditional houses

In general, the architectural elements that shape the facades of Diyarbakır traditional houses are as follows:

- Windows
- Doors
- Ewan
- Dislocations
- Gezemek
- Roof - eaves
- Ornaments - material

Because of the examinations conducted on Diyarbakır traditional houses, it was seen that many factors such as cultural values and climatic data were effective in both architectural planning and shaping the exterior facade.

5. FINDINGS

In this section, 14 L-plan typology houses of Diyarbakır traditional houses were analyzed using lindenmayer systems. The commands used in the Lindenmayer system alphabet and the rules defined for the formation of the branching and code strings of the selected traditional houses in Diyarbakır Sur district are shown in the Table 2.

Table 2 Commands used in the L-system alphabet for the branching and code string of traditional houses

Orientation Commands		
L-system code	**Definition**	**Agent behavior**
+(a)	left turn	The rotates left around the +x axis at angle or a defined angle
-(a)	right turn	Rotates right around the +x axis at angle a or defined angle
Drawing Commands		
L-system code	**Definition**	**Explanation**
f(a)	Jump ahead	Proceeds by d units or a defined extent without drawing a line
F(a)	Draw	It progresses by drawing a line in d units or a defined size.
Branch Commands		
L-system code	**Definition**	**Explanation**
[	start branching	starts the branch and saves the agent position
]	finish branching	finishes branching and returns to the saved position

The rules defined for branching with Lindenmayer systems are shown in the Table 3.

Table 3 Rules defined for traditional housing

Rules Defined for Traditional Housing		
Rule code	**Definition**	**Explanation**
3F	Main structure growth rule	Defines the code between floors in the main structure
2F	Secondary structure growth rule	Defines the direction the circles face in the secondary structure
(F)	Space formation	Defines space orientation
F	Height difference	Defines the elevation difference between spaces on the same floor

In the model prepared with Lindenmayer systems referring to plant growth and development, the main circulation structure and the primary and secondary structures branching from this structure provide the basic circulation of the building. The primary circulation defines the primary structure called the main structure and refers to the floor height. Secondary circulation is formed at the branching points depending on the direction of the residential spaces and connects to the areas of use. The expression of the L system code in which the growth simulation is realized is shown in the Figure 6.

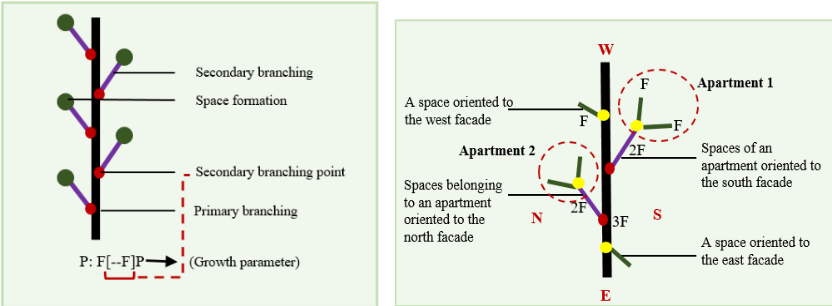


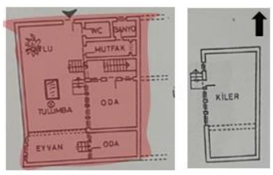
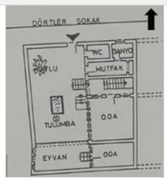
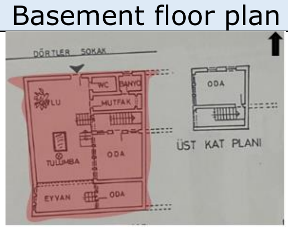
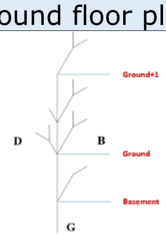
Figure 6 Schematic of growth, branching and space formation for traditional houses

With the defined commands, rules and branching principles, the space directions of the houses will be rewritten and branched with Lindermayer systems.

5.1. ANALYSIS OF L PLAN TYPE DIYARBAKIR TRADITIONAL HOUSES WITH LINDENMAYER SYSTEMS

Analysis data of 14 L-plan type Diyarbakır traditional houses made with Lindenmayer systems were transferred to analysis cards created for each building. Your structures; basement, ground and ground+1 floor data are included in the branching with reference to space orientations. In branching orientation, (K) defines the North direction, (S) the South direction, (D) the East direction, and (B) the West direction. The ada / parcel number and district names of traditional Diyarbakır houses are given in the table. However, for the parts whose information is not available, '?' used. Analysis cards of the buildings are given in Table 4-17.

Table 4 Analysis information of Building441-3

<table>
<tr><td>Building name: 1</td><td>Ada /Parcel : 441-3</td><td>District: ?</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F ->FFF(-FF(-F))FFF(+F(+F)(-F))(-FF(+F)(-F))FF(-FF(+F)(-F))(+F))FFF(-FF(-F)(+F)</td></tr>
</table>

Branching code string for the housing

Table 5 Analysis information of Building233-1

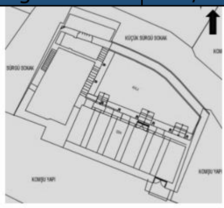
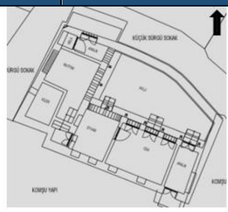
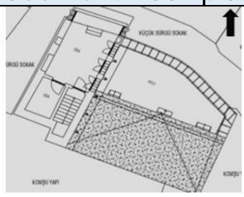
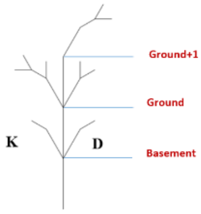
Building name: 2 Ada /Parcel : 233-1	District: ?
	
Basement floor plan	Ground floor plan
	
Ground+1 floor plan	Residential branching
Axiom: F, Angle: 30, StartAngle: 90 F ->FFF(-FF(-F))FFF(+F(+F)(-F))(-FF(+F)(-F))FF(-FF(+F)(-F))(+F))FFF(-FF(-F)(+F)	
Branching code string for the housing	

Table 6 Analysis information of Building419-2

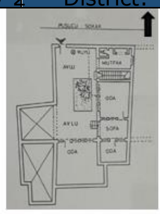
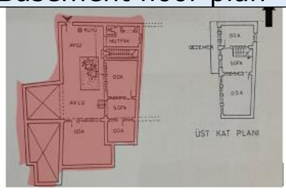
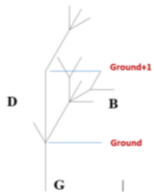
Building name: 3 Ada /Parcel :419-2	District: ?
	
Basement floor plan	Ground floor plan
	
Ground+1 floor plan	Residential branching
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(-FF(-F(+F)(-F))(+F(-F)(+F))(--F)F)(+F)FFF(-FF(+F)(-F)F	
Branching code string for the housing	

Table 7 Analysis information of Building417-22

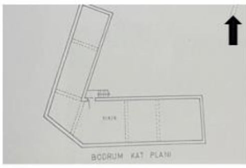
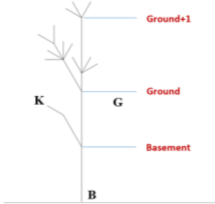
<table>
<tr><th>Building name: 4</th><th>Ada /Parcel :417-22</th><th>District: ?</th></tr>
<tr><td colspan="2">
</td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+FF(+F))FFF(+FF(+F)(-F)(++F)(--F)F(+F)(-F)))F(+F)(-F)(--F)))FFF((+F)(-F)(++F)</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
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Table 8 Analysis information of Building?-?

<table>
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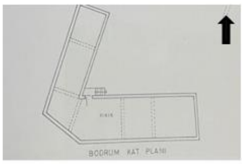
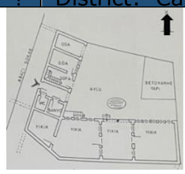
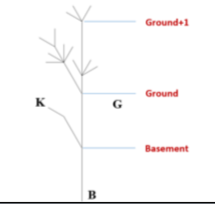
<tr><td colspan="2">
</td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF((+F))FFF(-FF(+F)(-F)(++F)(--F(+F)(-F)))((+F)(-F))FF((+F)(-F))FFF(-FF(+F)(-F)F</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

Table 9 Analysis information of Building?-?

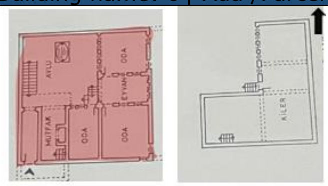
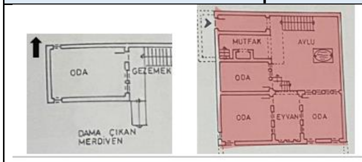
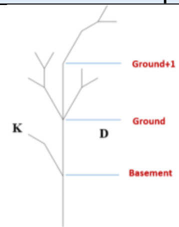
Building name: 6	Ada /Parcel :?-?	District: Savaş
		
Basement floor plan		Ground floor plan
		
Ground+1 floor plan		Residential branching
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(+FF(+F))FFF(-FF(-F)(+F))(+FF(+F)(-F(+F)(-F)))FFF(-FF(-F(+F)(-F))		
Branching code string for the housing		

Table 10 Analysis information of Building175-2

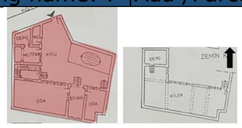
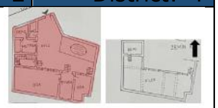
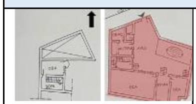
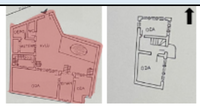
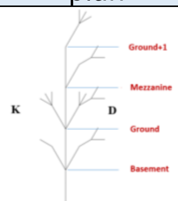
Building name: 7	Ada /Parcel :175-2	District: ?
		
Basement floor plan		Ground floor plan
		
Mezzanine plan	Ground+1 floor plan	Residential branching
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(+FF(+F))(-FF(-F(-F)(+F)))FFF(+FF(+F)(-F)F)(-FF(+F)(-F(+F)(-F))F)FFF(-FF(-F(-F)(+F))))FFF(-FF(+F)(-F)F)		
Branching code string for the housing		

Table 11 Analysis information of Building163-12

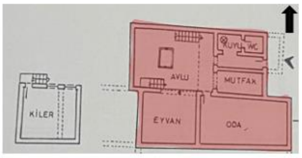
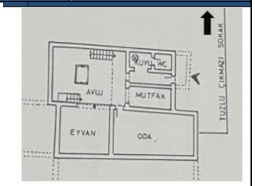
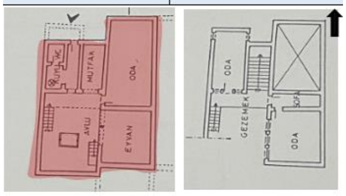
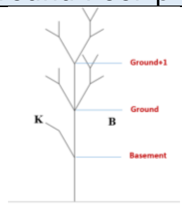
<table>
<tr><th>Building name: 8</th><th>Ada /Parcel :163-12</th><th>District: ?</th></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+FF(+F))FFF(-FF(-F)(+F(-F)(+F)))(+FF(+F)(-F))FFF(-FF(-F)(+F(-F)(+F)))(+FF(+F)(-F)</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

Table 12 Analysis information of Building288-7

<table>
<tr><th>Building Name: 9</th><th>Ada /Parcel :288-7</th><th>District: ?</th></tr>
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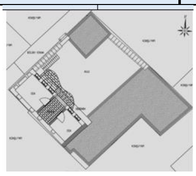
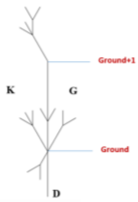
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+++++F(+F)(-F))(+FF(+F)(-F)F)(-FF(+F)(-F))FF(+F)(-F)F)FFF(+FF(+F)(-F(+F)(-F))F)</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

Table 13 Analysis information of Building304-2

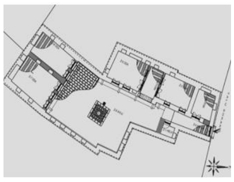
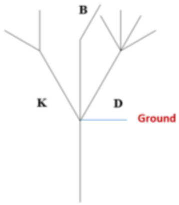
<table>
<tr><th>Building name: 10</th><th>Ada /Parcel :304-2</th><th>District: ?</th></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(-FF(-F)(+F)(++F)F)(+FF(+F)(-F))FF(-F)</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

Table 14 Analysis information of Building194-48/49

<table>
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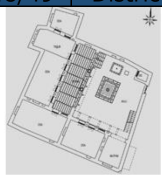
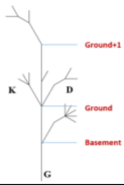
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(-FF(-F(-F)(+F)(++F)(--F)F))FFF(-FF(-F(+F)(-F)))(+FF(+F)(-F)F))FF(-F))FFF(+FF(-F)(+F(-F)(+F))</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

Table 15 Analysis information of Building218-2

<table>
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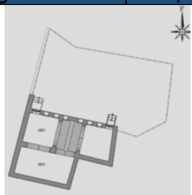
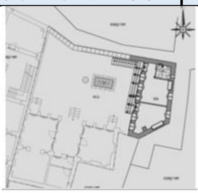
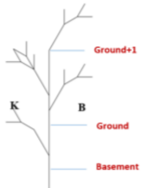
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+FF(+F(+F)(-F)))FFF(-FF(-F(+F)(-F))(+F))F(+FF(+F(+F)(-F))(-F)F(+F)(-F)))FFF(-FF(+F)(-F(+F)(-F))</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
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Table 16 Analysis information of Building193-55

<table>
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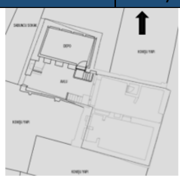
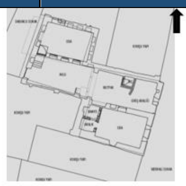
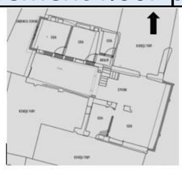
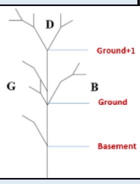
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Basement floor plan</td><td>Ground floor plan</td></tr>
<tr><td colspan="2"></td><td>
</td></tr>
<tr><td colspan="2">Ground+1 floor plan</td><td>Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+FF(+F))FFF(-FF(-F(+F)(-F)))(+F(+F)(-F))F(+FF(+F)))FFF(+FF(+F(+F)(-F))(-F))(-FF(+F)(-F)</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
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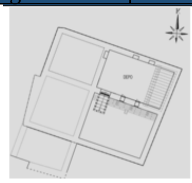
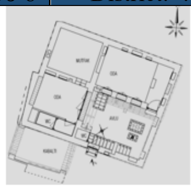
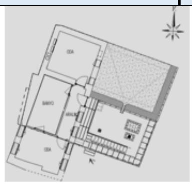
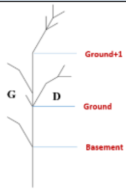
Table 17 Analysis information of Building196-8

<table>
<tr><th>Building name: 14</th><th>Ada /Parcel :196-8</th><th>District: ?</th></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Basement floor plan</td><td colspan="2">Ground floor plan</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Ground+1 floor plan</td><td colspan="2">Residential branching</td></tr>
<tr><td colspan="3">Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(+FF(+F))FFF(-FF(-F(+F)(-F)))(+F))F(+FF(+F))FFF(-FF(+F)(-F)F(-F)(+F))</td></tr>
<tr><td colspan="3">Branching code string for the housing</td></tr>
</table>

14 L-plan type traditional Diyarbakır house floor plans were branched with Lindenmayer systems. Numerical expressions such as 1,2,3,4 define the number of branches, and the expression 'number +' defines a space that has more than one space within itself . Branching data of the floor plans of the residences are given in Table 18.

Table 18 Branching of the l type plan typology

Building name	Basement floor	Ground floor	Mezzanine fFloor	Ground+1 floor
Building no. 1: 441-3	B:1	K:1+1 , B: 4		B: 2
Buildingno. 2: 419-2		K:1, B: 4+2		B: 3
Building no. 3: 417-22	K:1	K:5+1, D: 3		D: 3
Buildingno. 4: ?-? Cami Kebir	B:1	K:1, B: 2, G:4+1		G:3
Buildingno. 5: ?-? Savaş Mah	K:1	K:2+1, D: 1		D: 1+1
Building no. 6: 175-2	K:1 ,D:1+1	K:3 ,D:3+1	D:2+1	D: 3
Buildingno. 7: 163-12	K:1	K:2, B: 2+1		K:2, B: 2+1
Buildingno. 8: 288-7		K:3,B:2,G:2,D: 1+1		K:3, B:3, G:1
Buildingno. 9: 304-2		K:2 ,D:4, B:1		
Building no. 10: 194 - 48/49	D:1	K:3 ,D:1+1, B:1		B:2+1
Buildingno. 11: 218-2	K:1+1	K:3+1, B: 2+1		
Buildingno. 12: 193-55	G:1 ,B:1+1	G:1 ,B:1+1		G:1 ,B:2
Buildingno. 13: 196-8	G:1	G:1 ,D:1+1		D:3+1
Buildingno. 14: 233-1	K:1 ,D:1	K:2 ,D:2		D:1

14 L-plan type traditional Diyarbakır house basement floor plans were evaluated for branching. Because of the branching in the basement floor, it was seen that 1 branching was dominant in general. It was determined that the facade orientation of the spaces was

in the North direction with the highest rate of 42%. The general evaluation table for the basement floor in given Table 19.

Table 19 Basement floor branching evaluation in l type plan typology

Mezzanine floor	North	South	East	West
General branching %: %100 1D	1	1	1	1
	1	1	1	1
	1		1	1
	1			
	1			
	1			
	%100 1D	%100 1D	%100 1D	%100 1D
General facade orientation %:	%42	%14	%21	%21

14 L-plan type traditional Diyarbakır house ground floor plans were evaluated for branching. Because of the branching on the ground floor, it was seen that 1 and 2 branching was generally dominant. However, it was also seen that there are 3 branching with low rates. It was determined that the facade orientation of the spaces is in the North direction with the highest rate of 36%. The ground floor general evaluation in given Table 20.

Table 20 Ground floor branching evaluation in l type plan typology

Ground floor	North	South	East	West
General branching %: %36 1D %30 2D %18 3D %12 4D %4 5D	1	4	3	4
	1	2	1	4
	5	1	3	2
	2	1	1	2
	2		4	2
	3		1	1
	2		1	1
	3		2	2
	2			1
	3			
	3			
	2			
	%25 1D , %33 2D %33 3D , %9 5D	%50 1D , %25 2D %25 4D	%50 1D , %12 2D %26 3D, %12 4D	%33 1D , %44 2D %23 4D
General facade orientation %:	%36	%12	%24	%28

Because of the branching evaluation of 14 L-plan type traditional Diyarbakır house ground + 1 floor plans, it was observed that 2 and 3 branching was generally dominant. However, it was also observed that there were 1 branches with low rates. It was determined that the facade orientation of the spaces was in the East and West directions with the highest rate of 37%. The general evaluation table for the ground + 1 floor in given Table 21.

Table 21 Ground+1 floor branching evaluation in l type plan typology

Ground+1 floor	North	South	East	West
General branching %: %21 1D	2	3	3	2
	3	1	1	3
			3	2
			3	3
			1	2

%29 2D %50 3D	%50 2D , %50 3D	%50 1D , %50 3D	%40 1D , %60 3D	%60 2D , %40 3D
General facade orientation %:	%14	%14	%37	%37

Because of the analysis of 14 L-plan type traditional Diyarbakır houses with Lindenmayer systems; it was seen that the spaces in the basement have 1 branching and are oriented to the north. The spaces on the ground floor have 1 and 2 branches and are generally oriented to the North, but there are also spaces oriented to the West and East. On the ground + 1 floor, the spaces have 3 branches and are generally oriented to the West and East. However, it was also observed that spaces are oriented to the West and East.

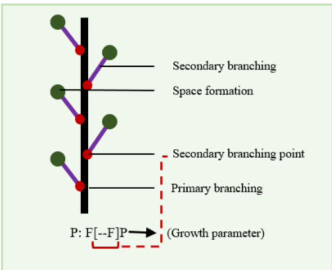
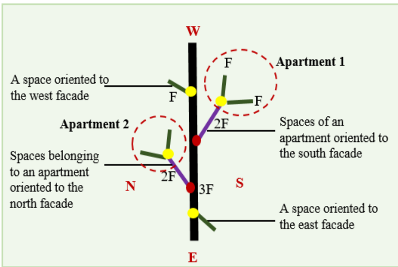
As a result of the analysis of 14 L-plan type traditional Diyarbakır houses with Lindenmayer systems; branching data of the floors and the directions they face were determined. Since ground floor data is important in the production of single houses, ideal housing typology will be produced by utilizing these data.

5.1.1. Use of lindenmayer systems as a productive system

The speed of L-systems in generating complex forms makes them an attractive generative system for architectural design (Aldemir, 2014). In the model designed using Lindenmayer systems, the bracketed DOL-system, one of the L-system grammars, was used because it was desired to create a branching structure. In addition, the strings derived by Lindenmayer systems depending on the number of belits, production rules and self-iterations were visualized using turtle graphs. The main circulation structure and the primary, and secondary structures branching from this structure provide the basic circulation of the Buildingin the model prepared with this method referring to plant growth and development.

The description of the L-system code where the growth simulation is performed for the proposed model in given Table 22.

Table 22 Growth, branching and space formation for ideal housing typologies

Growth, branching and space formation schemes for ideal housing typologies	
	

In addition, the algorithm flowchart prepared within the scope of the study is shown in given Figure 7.

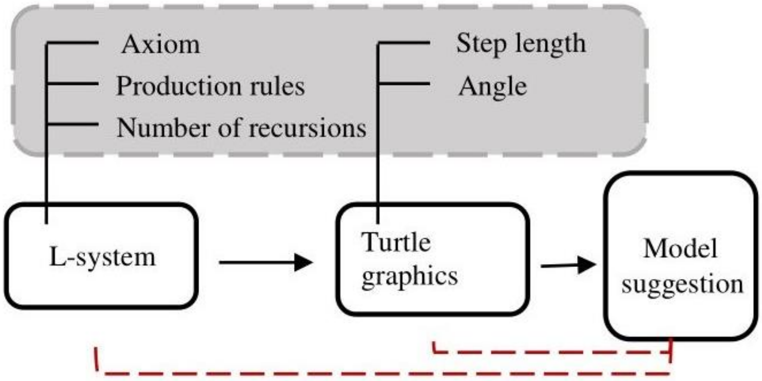


Figure 7 L-system algorithm flow diagram

The stages of an example growth algorithm can be described as follows.
- Establishing the axiom (initial state);
- Creating the growth rules of the main structure;
- Creating branching rules and adding them to the growth rules;
- Adding variables;
- Adding the use cases to the branching structure.

Also, turtle step length and orientation angle are used as variables in the model. The alphabet (symbols) from the book "The Algorithmic Beauty of Plants" by Aristid Lindenmayer and Przemyslaw Prusinkiewicz was used for the string derivation of L-systems and the use of turtle graphics .
The commands used in the L system alphabet for the branching and code sequence of the houses in the model are given in Table 23.

Table 23 Commands used in the L-system alphabet

Orientation commands		
L-system code	Definition	Agent behavior
+(a)	Left turn	The rotates left around the +x axis at angle or a defined angle
-(a)	Right turn	Rotates right around the +x axis at angle a or defined angle
Drawing commands		
L-system code	Definition	Explanation
f(a)	Jump ahead	Proceeds by d units or a defined extent without drawing a line
F(a)	Draw	It progresses by drawing a line in d units or a defined size.
Branch commands		
L-system code	Definition	Explanation
[	Start branching	Starts the branch and saves the agent position
]	Finish branching	Finishes branching and returns to the saved position

The symbols used in the Lindenmayer system alphabet are shown below.

V={F,+,-, [,]} (Alphabet)
ω: F (Axiom)
p: (Rule)
When defining the code string through the Lindenmayer program, three constants were determined. These are;
- F,

- angle,
- is the start angle.

F: It is defined as the first step the turtle will take. In other words, it is accepted as the initial axiom. The steps to be taken by the turtle vary depending on whether the multiples of F are decreasing or increasing.

Angle: It is one of the three constants specified in the program and is accepted as 30 degrees. Since the branching angle of the traditional houses is taken as 30 degrees, the same angle is taken as a reference for the new branches.

Start Angle: The start angle is another constant determined as the starting angle. Since the plant growth development is upward, the start angle is assumed to be 90 degrees.
In the proposed model, in the branching for the houses expressed as apartment types, the primary structure was used to define the floor difference and the secondary structure was used to determine the façade direction facing the spaces of the house.

The commands used in the Lindenmayer system alphabet and the rules defined for the formation of the branching and code strings of the houses in the model proposed for Diyarbakır are shown in the Table 24.

Table 24 Rules defined for branching with Lindenmayer systems for contemporary houses

Rules defined for ideal housing typologies		
Rule code	Definition	Explanation
3F	Main structure growth rule	Defines the code between floors in the main struture
2F	Secondary structure growth rule	Defines the direction the circles face in the secondary structure
(F)	Space formation	Defines space orientation
F	Height difference	Defines the elevation difference between spaces on the same floor
A1	House 1	Defines house type A1
A2	House 2	Defines house type A2
A3	House 3	Defines house type A3
A4	House 4	Defines house type A4
B1	House 5	Defines house type B1
B2	House 6	Defines house type B2
▲	Space orientation	Expresses the direction the spaces are facing
●	Connected space	Identify connected spaces

Within the scope of the study, the most appropriate module was determined by examining the room module dimensions of Diyarbakır traditional houses in order to form ideal apartment typologies. In line with the analyzes, it was seen that the short side of the rooms had dimensions ranging from 3-4 m and the long side had dimensions ranging from 6-7 m. In addition, rooms with a length of 3-4 m were intensively preferred in the houses. In the study prepared due to this, it was decided to use a the room module with a length of 3*4 m for the ideal typology formation. With this module growing and shrinking proportionally, all the spaces belonging to the residence were obtained. The modules used for the spaces designed in the ideal apartment typology formation are shown in the Figure 8.

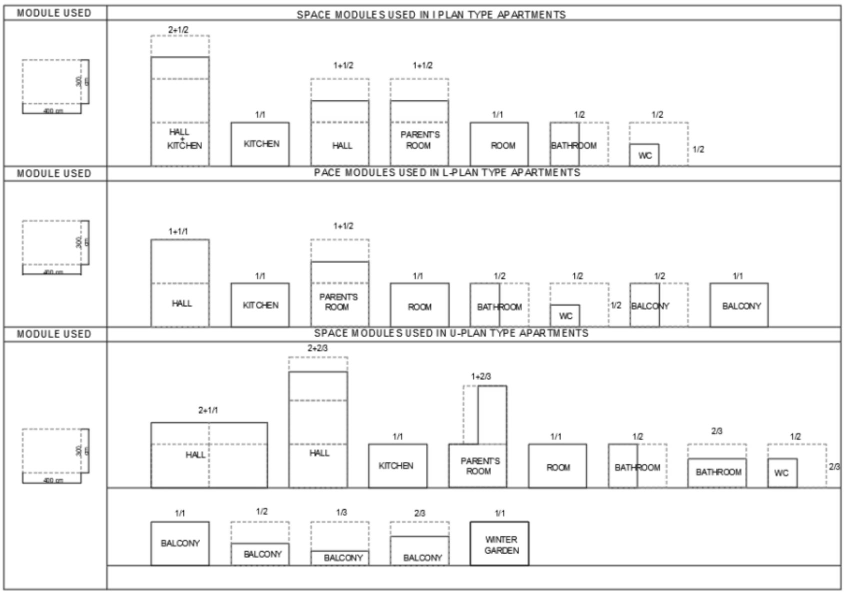


Figure 8 Modules used in ideal typologies

5.2. L PLAN TYPE PRODUCTIVE MODEL PROPOSAL WITH LINDENMAYER SYSTEMS

The façade orientation data obtained from Diyarbakır traditional houses with the L plan type are given below.

12% SOUTH -> D ,2D, 4D
36% NORTH -> D, 2D,3D ,4D
28% WEST -> 2D ,3D,4D
24% EAST -> D ,2D, 3D,4D

As a result of the Lindenmayer analysis conducted for the traditional Diyarbakır houses in the L plan type, it was determined that the façade orientation of the spaces was predominantly north.The number of branches with high branching density percentages for each facade in traditional houses is indicated in the red box. As a result of the data obtained, it was determined that the most suitable spatial orientation is north and then east, since Diyarbakir city climate has a continental climate with hot and dry summers and winters that are not as harsh and cold as in Eastern Anatolia. The effects of the continental climate in the province are reflected in the form of the buildings. This reflection is seen in the courtyard, which has become an integral part of the houses. While the average high temperature is 22.5 °C, it can reach 46 °C in summer. In this respect, when we look at the climatic data, it is seen that the most suitable direction is north and east. In the sample ideal typologies prepared, the spaces were oriented by paying attention to Diyarbakır climate and branching data.In the formation of ideal housing typologies, Lindenmayer systems, one of the productive systems, were used to create awareness in this sense. In this direction, ideal typologies were created with reference to the spatial orientation data of Diyarbakır traditional housing data in harmony with nature. With this logic, it will be possible to create countless sample typologies. Many different alternative examples can be provided either by having different floor plans or by differentiating the number of apartments to be designed on the floors.

In this study; for the design of the new houses, a new code string was defined through Lindenmayer systems by paying attention to the percentages and branching numbers of the facades facing the spaces in the traditional houses. The defined code string was branched and transferred to the plan plane in 2d at the same time. Through the data obtained, 2+1 and 3+1 houses were proposed for the L-plan type housing typology.
A: Defines the plan code of the L-plan type 2+1 housing type to be designed.
B: Defines the plan code of the L-plan type 3+1 housing type to be designed.

Within the scope of the study, the plan, branching image and code sequence of the L-plan type 2+1 house are shown in the Table 25-26-27-28.

Table 25 2+1 apartment with L plan type

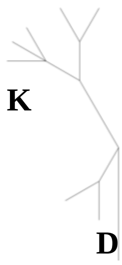
2+1 L Plan Type Housing String	
	
Plan image	Branching image
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F)F)	A 1: F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F)F)
Branching code string of the dwelling	A 1: Typesetting code for L plan type 2+1 housing type to be designed

Table 26 2+1 apartment with L plan type

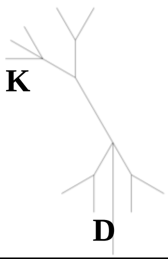
2+1 L Plan Type Housing String	
	
Plan image	Branching image
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(------(+F(-F)(+F))(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F)F)	A 2: F -> FFF(------(+F(-F)(+F))(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F)F)
Branching code string of the dwelling	A 2 : Typesetting code for L plan type 2+1 housing type to be designed

Table 27 2+1 apartment with L plan type

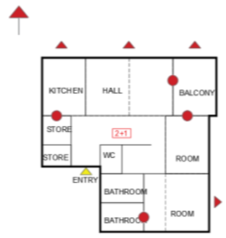
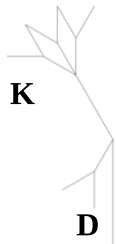
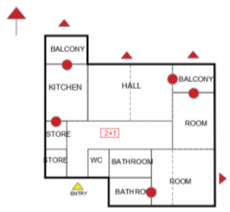
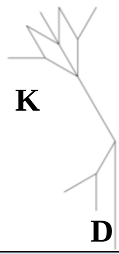
2+1 L Plan Type Housing String	
	
Plan image	Branching image
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))(F(+F)(-F))	A 3: F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))(F(+F)(-F))
Branching code string of the dwelling	A 3: Typesetting code for L plan type 2+1 housing type to be designed

Table 28 2+1 apartment with L plan type

2+1 L Plan Type Housing String	
	
Plan image	Branching image
Axiom: F, Angle: 30, StartAngle: 90 F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F)F)	A 4: F -> FFF(------(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F)F)
Branching code string of the dwelling	A 4: Typesetting code for L plan type 2+1 housing type to be designed

Within the scope of the study, the plan, branching image and code string of the 3+1 house with the L plan type are shown in the Table 29-30.

Table 29 3+1 apartment with L plan type

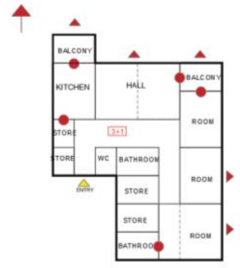
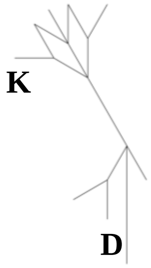
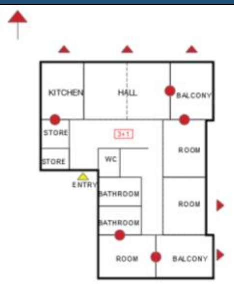
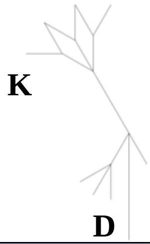
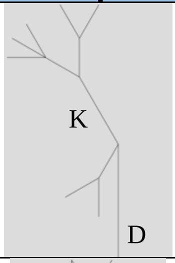
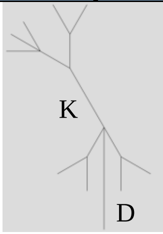
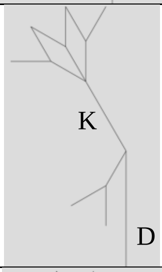
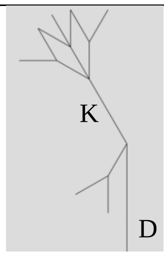
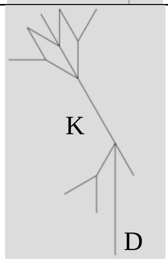
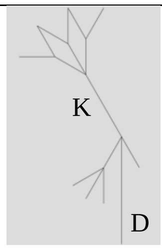
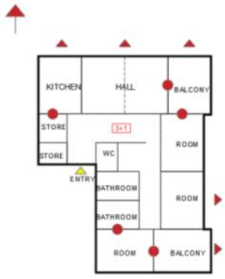
<table>
<tr><th colspan="2">3+1 L Plan Type Housing String</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Plan image</td><td>Branching image</td></tr>
<tr><td>Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(------(+F)(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F)F)F</td><td>B 1 : F -> FFF(------(+F)(-F(+F)(-F)))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F)F)</td></tr>
<tr><td>Branching code string of the dwelling</td><td>B 1: Typesetting code for L plan type 3+1 housing type to be designed</td></tr>
</table>

Table 30 3+1 apartment with L plan type

<table>
<tr><th colspan="2">3+1 L Plan Type Housing String</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Plan image</td><td>Branching image</td></tr>
<tr><td>Axiom: F, Angle: 30, StartAngle: 90
F -> FFF(------(+F)(-F(+F)(-F)F))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F))</td><td>B 2 : F -> FFF(------(+F)(-F(+F)(-F)F))(+FF(-F(+F)(-F))(+F(+F)(-F))F(+F)(-F))</td></tr>
<tr><td>Branching code string of the dwelling</td><td>B 2: Typesetting code for L plan type 3+1 housing type to be designed</td></tr>
</table>

Numerous typologies can be produced with these branching graphs determined depending on the directions. General data regarding the plan types and branching graphs prepared within the scope of the study are shown in Table 31.

Table 31 Example ideal typologies and branching graphs with L plan type

Plan Type	Branching Graph	Sample Ideal Plan Types	Branching Graph	Sample Ideal Plan Types
L PLAN TYPE				
				
				

6. CONCLUSION AND RECOMMENDATIONS

The concept of computer-aided design, which continues to change with the developments in the field of technology, has found a wide usage area in the discipline of architecture. Today, architects use CAD as a generative system in alternative and creative design processes in conceptual design processes with the contribution of parametric methods and evolutionary strategies. When its historical development is analyzed, it is seen that the use of algorithmic and generative processes contributed to architects in developing new alternatives in the design of high-rise buildings, one of the building types where formal differences are felt the most.

Computational approaches, which have shaped the change in design culture in recent years, play an important role in contemporary design practices. The integration of computational approaches into the design process enables the development of new design solutions that are difficult or impossible to achieve with other methods.

The use of context in the design process is also important for sustainable designs, because it includes the user factor and designs in harmony with nature. It is important in terms of the ease of intervention, flexibility, solution and sustainability of existing architectural languages that are user-oriented and harmonious with nature.

In the present study, using the Lindenmayer system program, L-plan type traditional Diyarbakır houses were coded by rewriting method and the branching model was determined structurally. According to the data obtained, it was determined that the branching model of traditional houses is more compatible with plant growth in nature and is naturally formed. This branching data of traditional houses should be taken as a reference for new houses to be built in the region. For this purpose, traditional houses were analyzed and branching graphs were determined with the data obtained depending on the direction parameter and six ideal housing typologies were produced based on these graphs. Many alternative typologies can be produced with this method, but the method used will create an awareness in terms of computational design in our country and in this respect, the sustainability of the architectural language of the buildings in the historical texture can be ensured with this method. It is important for this method to be an example for new houses to be built in many historical textures of the country in terms of the sustainability of the architectural language specific to the region.

Authors' Contribution
The authors contributed equally to the study.

The Declaration of Conflict of Interest/ Common Interest
No conflict of interest or common interest has been declared by the authors.

The Declaration of Ethics Committee Approval
This study does not require ethics committee permission or any special permission.

The Declaration of Research and Publication Ethics
The authors of the paper declare that they comply with the scientific, ethical and quotation rules of SAUJS in all processes of the paper and that they do not make any

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