Kaunas University of Technology

Faculty of civil engineering and architecture

Architectural Patterns Language and Possibilities of Its Parametrization

Master's Final Degree Project

Natanael Efrain Lopez Arce

Project author

Prof. Kęstutis Zaleckis

Supervisor

Kaunas, 2021

Kaunas University of Technology

Faculty of civil engineering and architecture

Architectural Patterns Language and Possibilities of Its Parametrization

Master's Final Degree Project

Architecture (6211PX026)

Natanael Efrain Lopez Arce

Project author

Prof. Kęstutis Zaleckis

Supervisor

Lect. Gintaris Cinelis

Reviewer

Kaunas, 2021

Kaunas University of Technology

Faculty of Civil Engineering and Architecture

Natanael Efrain Lopez Arce

Architectural Patterns Language and Possibilities of Its Parametrization

Declaration of Academic Integrity

I confirm the following:

1. I have prepared the final degree project independently and honestly without any violation of the copyrights or others' rights, following the provisions of the Law on Copyrights and Related Rights of the Republic of Lithuania, the Regulations on the Management and Transfer of Intellectual Property of Kaunas University of Technology (hereinafter – University) and the ethical requirements stipulated by the Code of Academic Ethics of the University.

2. All the data and research results provided in the final degree project are correct and obtained legally; none of the parts of this project are plagiarised from any printed or electronic sources; all the quotations and references provided in the text of the final degree project are indicated in the list of references.

3. I have not paid anyone any monetary funds for the final degree project or the parts thereof unless required by the law.

4. I understand that in the case of any discovery of the fact of dishonesty or violation of any rights of others, the academic penalties will be imposed on me under the procedure applied at the University; I will be expelled from the University and my final degree project can be submitted to the Office of the Ombudsperson for Academic Ethics and Procedures in the examination of a possible violation of academic ethics.

Natanael Efrain Lopez Arce
Confirmed electronically

KAUNAS UNIVERSITY OF TECHNOLOGY
Faculty of Civil Engineering and Architecture

Topic (thematic) of the Master's Final Degree Project: Architectural Patterns Language and Possibilities of its Parametrization
The topic of the Master's Final Degree Project is approved by the Dean's Order: Architectural Patterns Language and Possibilities of its Parametrization

Master's **Final Degree Project** (study module M000M168)

T A S K

Objective of the work:

To prepare the Master's final degree project based on the previous stages of the research work.

Tasks of the work:

To connect and summarise the data from the literature sources, analytical paper, research in situ report and experimental project, and prepare the Master's thesis – to present the reasoned solutions to theoretical and practical problems.

Structure of the work:

Text. Title page, heading page, declaration of academic integrity, task of the final degree project (FDP) (if needed), summary, santrauka, content, list of figures (if needed), list of tables (if needed), list of abbreviations and terms (if needed). Main part: introduction (relevance and novelty of the work, research problem and the level of its examination, object, objective, tasks, and methodology of the FDP); augmented and summarised data of theoretical research, empirical research and experimental design; conclusions of individual chapters and the entire work. List of references, list of information sources (if needed), appendices, copies of the graphical part (reduced in size).

The volume of the text (main part) is 2 – 3 quires (1 quire is 40 000 characters with spaces), i.e. around 60 – 80 pages of printed text (recommended font is Times New Roman, size 12, line spacing multiple 1.15 (Methodological Guidelines for the Preparation of Written Works)).

Graphical part.

The graphical part of the work is presented in posters (70x100 cm). It should reflect the most important results of the analysis of theoretical material, empirical research and experimental design, as well as general conclusions and proposals. The graphical part of the work should be arranged and exhibited in a way to form a visually unified whole and reflect the content of the work. It should be attractive aesthetically. When preparing the graphical part of the work, it is necessary to exclude the non-essential information, highlight the most important research results and ideas, and unify the notes, graphical expression, and colours.

The most expressive part of the project should be the experimental project, illustrating the conceptual proposals of solutions to problems. The experimental project should make from **3/5** to **4/5** of the graphical part.

The volume of the graphical part is 10 – 16 posters, of 70 x 100 cm size (vertically oriented).

Inscriptions of the graphical part should not be smaller than 5 mm in size.

Model (according to the need and possibilities).

Digital copy of the text and graphical part of the final work.

Timetable of the performance of the tasks:

1. Discussion of the task	03 02 2021
2. Constitution of the writing programme of the final work and the work's structure	10 02 2021
3. Supplementation, structuring, analysis and generalisation of the present data	until 17 03 2021
4. Review and evaluation of the supplemented and generalised data	**17 03 2021**
5. Writing of the FDP text and finishing of the graphical part	until 05 05 2021
6. Review of the first edition of the FDP text	**05 05 2021**
7. Defence of the FDP at the commission of supervisors	**12 05 2021**
8. Public defence of the FDP	**31 05 2021**

Consultation time with supervisor

Weekday	**Faculty of Civil Engineering and Architecture, Room 311, Zoom or other distance learning platform**	**Workplace**
	Time and duration *	**Time and duration ***
Monday		
Tuesday	**12:00 am – 13:30 pm, zoom**	
Wednesday		
Thursday	**12:00 am – 13:30 pm, zoom**	
Friday		

* - 2 hours per week

Supervisor of the final degree project Prof. Kęstutis Zaleckis
(name, surname, signature)

Student Natanael Efrain Lopez Arce
(name, surname, signature)

February 2021

Natanael Efrain Lopez Arce. "Architectural Patterns Language and Possibilities of Its Parametrization". Master's Final Degree Project / supervisor Prof. Kęstutis Zaleckis; Faculty of Engineering and Architecture, Kaunas University of Technology.

Study field and area (study field group): Architecture / P090

Keywords: Patterns, architectural patterns, composition elements, composition syntax, space syntax, parametrization, CAD.

Kaunas, 2021. 136.

Summary

Nowadays, object and designs tend to become more complex, and we start to denotate intricate relationships on them, which were not appreciated before, in that direction architecture itself is directed into a path that merges at some point with the mathematical field; what leads to comprehend or see the architecture from a semantic point of view. In an advanced understanding it has been tried to not only analyze the mathematical profile of architecture but recognize how it can be linked with the perception, understanding and analysis of the value from their aesthetics characteristics.

It is within this panorama that it has been tried to acknowledge how aesthetic is composed a building from the pattern’s perspective, interpretating the design value, over their composition features such as a symmetry, asymmetry, rhythm, and other ones. To understand the mentioned before this research explores topological frames from buildings facades to generate the pattern that later is applied and emulated in a project example that fits with the reality and context of Kaunas city generating the application from the building façade patterns analysis with the purpose to reinforce the model application and the projection of the method for further studies.

Natanael Efrain Lopez Arce. “Architektūrinių paternų kalbos parametrizavimo galimybės”. Master's final project / supervisor Prof. Kęstutis Zaleckis; Kauno Technologijos Universitetas, Statybos ir architektūros fakultetas.

Studijų sritis ir krypties grupė: Architektūros / P090

Reikšminiai žodžiai: Modeliai, architektūriniai modeliai, kompozicijos elementai, kompozicijos sintaksė, erdvės sintaksė, parametrizavimas, CAD.

Kaunas, 2021. 136 p.

Santrauka

Šiais laikais objektai ir dizainas tampa vis sudėtingesni, o mes pradedame atkreipti dėmesį į dalykus, kurie anksčiau nebuvo vertinami. Todėl architektūra vis labiau pasuka į kelią, kuris tam tikru momentu susilieja su matematikos lauku, kas veda suvokti ar pamatyti architektūrą semantiniu būdu. Išplėstinai buvo bandoma vertinti ne tik matematinį architektūros profilį, bet ir suvokti, kaip tai gali būti sujungta su estetinėmis savybėmis.

Šiose procesuose bandyta suvokti, kaip estetika susideda iš pastato modelio perspektyvos, interpretuojant dizaino vertę ir palyginant su tokiomis jų kompozicijos savybėmis kaip simetrija, asimetrija, ritmas ir kiti. Siekiant suprasti minėtą temą, prieš šį tyrimą tirta topologiniai pastatų fasadai. Gautas modelis, kuris vėliau būtų naudojamas ir imituojamas projekto pavyzdyje, atitinkantis Kauno miesto tikrovę ir kontekstą. Generuojant pastato fasado modelius, analizuotas taikymas, taip siekiant prognozuoti tolimesnius tyrimus.

Table of contents

List of figures

List of tables

List of abbreviations and terms

Abbreviations:

CAD – Computer Aided Design.

N.U.R.B.S. - Non-Uniform Rational Basis Spline

RJMCMC - Reversible-jump Markov Chain Monte Carlo

Terms:

Aesthetics – A set of principles concerned with the nature and appreciation of beauty.

Archetypes – Molded as a model.

Bias – A disproportionate weight in favor of or against an idea or thing.

Cast in situ – Put in place.

Façade – The principal front of a building.

Fractal – is a pattern that is repeated infinitely.

Fractal geometry – is the geometry that holds fractal dimensions.

Input – What is put in, taken in, or operated on by any process or system.

Intelligibility – Being able to understand it (The degree at which something is being understood).

i-value – Refers to the location memory that identifies an object.

J-graph – A graph drawing open-source software component available for the Java.

Layout – Is the element and parts arrangement through a specific frame.

Layer – is the different frames between an object shape.

Mathematical graph – is the mathematic structure applied to the study of graphs over the relationship of objects through vertices and edges.

Node – is the point at which two or more lines cross or connect.

Non-Uniform Rational Basis Spline – refers to a model of curves system used to represent surfaces and curve in computer graphics system.

Paradigm – is an example and pattern from a distinctive object.

Parameter – is a value that determine the limits from a specific task.

Parametric architecture – is the architecture that is related with use of parameters.

Pattern – is an element that goes in repetition holding his essence.

Pattern language – is the interpretation of how the pattern can communicate an idea or statement.

Polyline – A continuous line composed of one or more line segments.

Reversible-jump Markov Chain Monte Carlo – is a simulation method applied to spaces over posterior distribution with variation on dimensions.

Script – An automated series of instructions carried out in a specific order.

Semantic – is the meaning and significance from a language.

Topology – The way in which constituent parts are interrelated or arranged.

Variables - Number or quantity that varies (Factor that varies).

Introduction

Architecture as a discipline has been under different changes along the periods and time; as a result, in these days architecture "tend" to give the impression of not being related or connected with some basics principles (Hillier, Is Architectural Form Meaningless?, 2011) or sometimes these ones have been transformed and people don't have the capacity to recognize it, if it is observed through the composition features that they had. (Salingaros, Design Patterns & Living Architecture, 2017).

Consequently, it was presented that the architects' point of view as designers shaping the visual environment which gave a definition of aesthetic (Nancy Al-Assaf, 2014); in addition, the users' perspectives were present, who nowadays are consuming more complex visual ideas from us the "designers in general"; as result, it generates on the users a new composition on the visual perception from the buildings that were not investigated.

Furthermore, the lack of common identity and the statement of uniqueness is causing a sensation of detachment from the composition design principles (Ching, 2007). Therefore, many investigations tried to observe this effect of non-attachment through a descriptive position without an objective correspondent evidence. In that position, under Christopher Alexander's investigation, he tried to explain the objective side of designing from the interpretation of beauty through the construction of a mathematical model (Alexander, Notes in the synthesis of the form, 1973); simultaneously, his investigation conducted to the publication of pattern studies where he discovered that patterns are capable to represent the implicit nature manifestation of forms (Alexander, A pattern language, 1977). Thus, converging in a point where the argument about beauty exists in the physical realm as an expression of nature, earning the characteristic of living structure, connecting them with the surroundings, with the capacity to be measured and quantified mathematically (Jiang, 2019).

Considering that Alexander's pattern theory opened a new frame over his pattern paradigm providing the chance to study his theory over the praxis of a mathematical method. Other authors, like Hillier, incorporates into his own investigation this analysis in some examples using the tool space syntax through urban scale, studying the relationship between the data collected and the citizens behavior; also using it in some buildings layouts to study the space connectivity and measure the equilibrium and symmetry over facades samples (Hillier, Space is the machine, 1999). Similarly, a research held by Nikos Salingaros tried to simultaneously explain this analysis of symmetry and changes on some facades using the theory of fifteen patterns from C. Alexander, explaining not only the pattern structure but also the importance of symmetry over the fifteen patterns (Salingaros, Complexity in Architecture and Design, 2014).

From the previous explanation it was conjectured that the research over façades require a further analysis beyond symmetry because the façade could have the capacity to have a complex nature result, and, based on previous studies were urban spheres and the layout plans were applied, this option provides the opportunity to decipher the impact of other composition elements in the facade following the studies of fractal geometry under the pattern language theory along the scale of hierarchy that they represent; for that reason, the object of this research is the analysis of architectural patterns on façade and our objective is to test the possibility of parametrization from the architectural pattern's façade.

The main tasks to address the main object and objectives were:

1. Evaluate the previous investigations and research on building facades analysis examples through case studies.
2. Analyze the mathematical models provided in previous studies (e.g., fractals, graphs, formulas, etcetera) which would allow us to reformulate a mathematical description from the patterns.
3. Compare the level of aesthetics perception between some sample façade analysis using CAD tools and a sociological survey.
4. Identify architectural patterns from the nearest buildings to the project proposal.
5. Implement the parametrization of patterns on the design proposal over the principal façades.

Hence, the methodology of this research is divided into the following chapters:

Chapter 1, is the analysis of existing research papers and books that are about theory of architecture, the semantic interrelation over the paradigms that had an impact during the evolution of theory application to facades, and about the analysis of mathematical graphs and fractal geometry aligned with comparison of examples explaining the use of pattern application on the façades and other existing samples, such as urban fields to generate the basis information to propose the theoretical model for this research.

Chapter 2 is the materialization of aesthetic sociological survey from three main paradigms that were analyzed in the literature review. From each paradigm three representative buildings were chosen, regardless of the capability to identify composition features from them. Concurrently, through space syntax tool with implementation of axial maps it was evaluated the integration, connectivity, number of node and choice.

Along with the evaluation, each sample façade was created through CAD models. With this it was possible to establish a relation between the results from the survey and the depth map tool, to sustain the hypothesis through the hypothetical model.

Chapter 3 corresponds to the implementation of the findings in chapter 2 in order to re-create the patterns, which was done under the design of an architectonical building. According to the information analyzed the experimental design was set in Kaunas city. Moreover, a local interview was conducted to focalize the building typology and by doing a site analysis, project justification and application of architectural pattern from the nearest buildings it was emulated the findings from the hypothetical model that was modified after results. At last, the research ends with the conclusion and discussion about the summary of implemented procedures results.

The novelty in this research consists to set out pattern descriptions implementing space syntax as mathematical tool to produce guidelines in the sense to be parametrized using parametric design tools. The praxis from this research entails the possibilities to expand over future explorations, to connect and discover more patterns from buildings façades.

1. Theory of architectural pattern in architecture and its relationship with building facades

This chapter helped to understand the first layer of significance related to the term and definitions for this topic, considering that in this digital era the terminology for architecture term is mentioned into other fields; for example, the informatics science, in spite of the differences, both share a particularity implied in a small relationship from which Karatani expressed how the term architecture also possesses a philosophic etymology despite of the Greek terminology; for this, she relates with the philosopher Plato, who in his interpretations and his relationships with arts and mathematics made use of the term architecture (Leszl, 2006). Karatani makes a new reference of the concept, as well as Nietzsche that proposed a new interpretation of the etymology (Karatani, 1995). However, this explanation was the path to understand and analyze the dimension of the concepts that were applied in this investigation.

Nevertheless, the change of paradigms over time and the curiosity to find a deeper understanding of the term, mixing with the philosophical aspect like Karatani mentioned looking the introspective path of terms and recognizing the surroundings is presented by the pattern theory from Cristopher Alexander, where his acquirements on the observation produce one of the most influencing results since 1977 (Alexander, A pattern language, 1977), based on his book this research used his investigation as a starting point to induce a deeper understanding on the buildings that could have an influence from the aesthetics side.

However, buildings are the collections of time or as the musician Johan Wolfgang Von Goethe mentioned “I can call architecture frozen music” (Goethe, 1839) more than this expression, he expressed that necessities produced by humans are result of new ideas, but that result is enclosed in a period of time where this investigation tried to separate organizing them in four main paradigms: the classicism, the modernism, the CAD and the pattern paradigm; because this relationship is a timeline that overlap in a paradox of causes and consequences, and considering them would reveal the frame where the aesthetics, the patterns and other elements were designed on the buildings, like Von Goethe seeing the frozen aspects from the paradigms where it can be observed the substantial differences used in this research.

Moreover, the differences that a building can demonstrate through their façades is based on a methodological analysis that should be compared with previous examples. In this chapter it was described how this analysis scheme could have the possibility to explore other results, emulating them to set the first analysis of theoretical model of this research.

1.1. Semantic point of view from the architecture conceptualization

Firstly, how can architecture be understood as a main concept? without another interpretation, to analyze it, it was needed to explore the definitions further from the dictionary, to think about the conceptualization of this noun and consider that it could be connected with a lifestyle, conceiving the conception that architecture is a path to follow, understandable from an imaginative point of view (Shepheard, 1994). Associated with this research the definition about architecture suggested to understand it as a process that combines many steps aligned with one point of view (Vallentine, 2002). Due to it, it had the capacity to engage different understandings & approaches: from the visual understandings with drawings, to the creative results from the imagination realm and the generative ones that converge in the physics design; for that reason, all of them helped to generate the idea and the concept about how architecture could be understood as a process which interacts in the duality world of transfer information (Farrelly, 2007).

As summary, in general terms how the concept of architecture is conceived and works as a first idea in the perceptive environment and how similar is with this research topic:

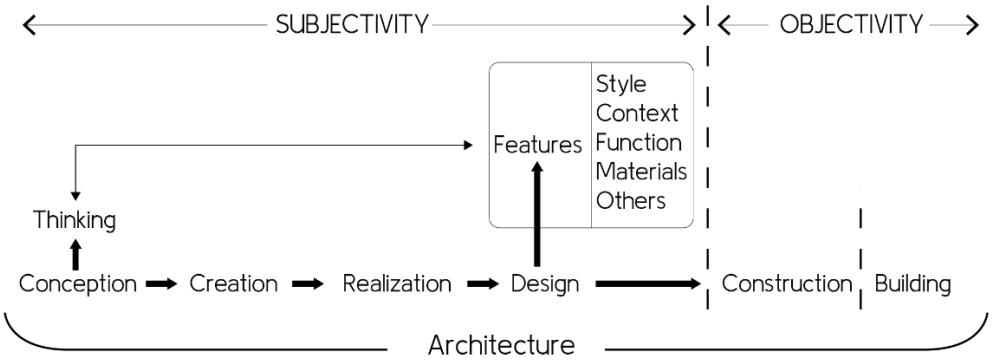


Fig. 1. Architecture creational process by author.

In this graph it is split the conception of architecture going from the left as a subjective side to the objective in the right.

Architecture is a process, based on figure no. 2, it exposes from the beginning the statement that architecture goes through different stages of subjectivity to reach the objectivity that in the image ends in the building or project, but at the end is a process that follows some pattern and guidance. For that reason, the materialization of the idea is mainly the result of steps that can be identified and summarized with the purpose to identify more patterns in the object (design) itself, as well as in their elements, but firstly it should be identified over the senses, and architecture is one that is firstly appreciate in the visual frame. The frame creates in the user the first conception of architecture (the reaction one), that comes based on the result from the process of idea materialization, but in this research the architecture as a whole, had a hidden dimension for being intelligible and somehow understood.

For instance, since Bill Hillier, started to argue how the architecture is a law connected in both directions; For example, the first, the real one is related to the vernacular stage which responds to the environment (Rudofsky, 1973); and the second one, that is more elaborated and belongs to the world of theorization. This interpretation of architecture, based on the argument from Hillier suggests that form and space enclose the utility of any object, and the vernacular object gets transformed into a more elaborated representation of shapes molded by the creativity (Hillier, Space is the machine, 1999).

For that reason, the interpretation from the social configuration and the aesthetics were previously analyzed by Cristopher Alexander (Alexander, Notes in the synthesis of the form, 1973), following some behaviors that could be named in the future "patterns" from the technique of interpretation about this type of results on the design process into the statement that the addition which attends to modify the object, could be understood as a base of systematic knowledge, generating that the architecture will be at the end: a production of features with properties in the space, interacting between one another, in the scope of form and space.

In the aim to understand architecture as a primarily concept, subjectivity is part of the understanding that was explained in the figure no. 2, even though this came from a professional or not all the time; but, from the point of view of Hillier (Hillier, Space is the machine, 1999) this answer relates to the concept of addition, that from this point in this thesis is related with the name of "attributes", because these are all the time interacting with the frame of the object.

These attributes have the possibility to change the way how the object is perceived by the user in the final stage of architecture; because architecture at the end is the compilation of numerous information that have inner properties as Hillier mentioned in the beginning (Hillier, Space is the machine, 1999), without them the architecture is just a description in the mental map like in figure no. 1. For that reason, it is important to clarify that the concept in this topic belongs to those attributes that create the approach of aesthetics in architecture and how this is or is not interpreted by the professionals and the users, creating the conjunction in a solid manner to see architecture supported by information.

Summarizing the conception of this type of interpretation is presented between the lines of subjectivity and objectivity conception of architecture:

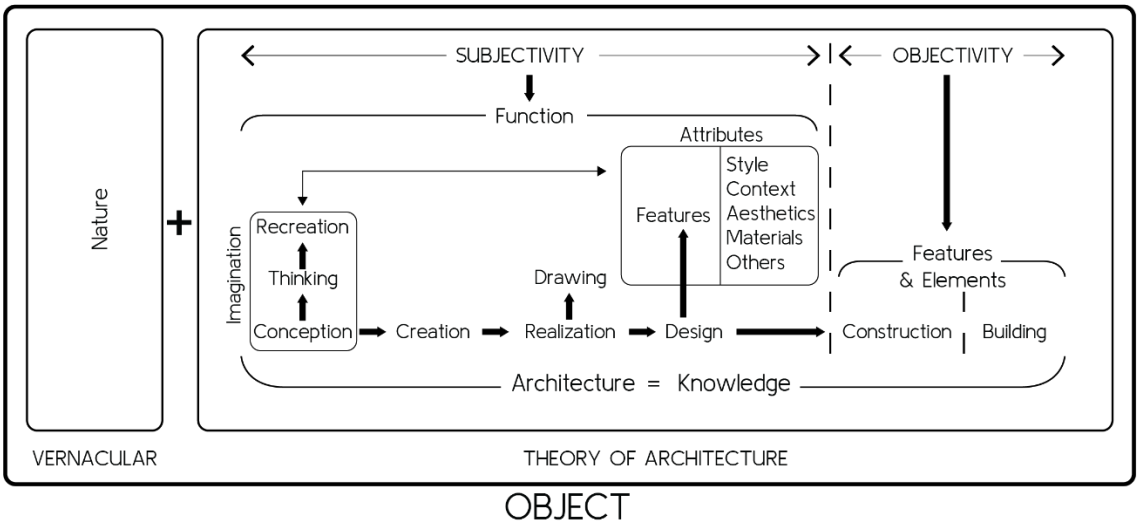


Fig. 2. Diagram of the interpretation from the conception of architecture based on theory of B. Hillier and C. Alexander by author.

This graph represents how the process of architecture is a compound of elements that interact between each other allowing to reveal the aspects to study: the attributes.

This conception or construction derives that architecture is a capsule of knowledge, for that reason different statements can be implied; for example: One is the interpretation by the people or users, because each characteristic is named and referred by them based on their experience or the ability to see it in an abstract way. The previous statement opens the frame through the analogy with the grammatical definition of a verb in a sentence because architecture might be a description of an action that it should be connected or interconnected with itself, intending to give meaningful criteria to the design concept (Eckert, 2000). In consideration, to understand architecture as it was mentioned in the beginning of this research, the relationship between the attributes and the object will be pointed. Simultaneously, those attributes would have the capability for being clearly named and identified with the interest to understand the information that came from the object as a language and the interconnection that could present (Horn, 1998).

Even so, this relationship is possible when the configuration of the object's attributes has the facility to interact in the language as it is known, applying the semantic disposition between the words and its interpretation on the universe, considering each element "as particular" or identifying them as a compound of everything to keep or transform its meaning.

Correspondingly, architecture is the combination of many elements, that should be described by its own. Consequently, the design emerges in a compilation of descriptions that had internal references, these references at the same time can have characteristics from the object, such as shapes, dimension, arrangements, colors, patterns, and others. As a result, the design evolves in a compilation of elements placed in the space following a pattern of elements.

In view of the previously mentioned the path to arrange the information for further analysis uses the syntaxis approach, where the syntax is identified as the order of principles that holds the structure from the objects as a language and study the possibility to identify the syntax rules from the design's (object) elements like many languages have (Carnie, 2007, pp. 5-11). But this decoding part operates in the cognition of abstract features that sometimes the users and designers don't understand, especially this type of information; but the possibility to use the syntax method will provide a way to structure this abstract arrangement of features that could be understood in different levels from the simple to the complex one.

To construct the idea towards the syntax is necessary to create a source-language where the elements and features will be understood, because at the end, it is needed to address the statement related with the architecture as a language; as a result, the use from the semiotic approach whereas from the visual frame of imagination coming from buildings or architectural objects provide a simple structured guidance represented by a sign or any typology with elements crossing the boundaries from a simple understanding to a more elaborated syntax diagram.

As it was mentioned before it can be suggested that the syntax diagram should be a compound of attributes or elements that derive from the object, and at some point, the question about how the building acquires these attributes, and which ones should be named, from here the interest of this research is to connect the relation of attributes with the patterns that could represent the object.

Considering the design as a process, a natural one where many elements are configured to grant the building characteristics and create the uniqueness that it would have, this configuration in relationship with the object create in the perception the capability to understand the architecture from their form and aesthetics. As far as the aesthetics (Leyton, 2006) is the result of these conjugations and configurations where these "things or additions" in the composition side are understood in the world of design (Pelt, 1902) such as:

a. Balance (Symmetry)

b. Contrast

c. Unity

d. Scale (Proportion)

The possibility to recognize the attributes in the design file, is the way to assign them a characteristic beyond a meaning, because sometimes some of them are not recognizable to the users. As Hillier mentioned in his book, the human mind has the capacity to go to the intuitive side but not to the analytical side (Hillier, Space is the machine, 1999).

The design is a creative process that goes through different phases, sometimes in order or sometimes comes from the chaos (Rubinowicz, 2000), but at the end, each method tried to satisfy the objective from the social nature of the object as Alexander tried to systematize (Alexander, Notes in the synthesis of the form, 1973). Hence, the design suggests the following determined rules, clearly synthetizing the statement of each style that it is already know; from the style, is the summary of theorization from the ancient times as the examples provided by Palladio (Ruskin, 1880), Alberti and even Jean Jenaret (Jeanneret, 1980). The praxis of the exercise from the theory, is the intention to give significance to the elaboration of the idea to provide a clear visualization from the attributes and how they interact is the prior for this investigation like Hillier and Salingaros made it, with the property of equilibrium, that is one attribute in the composition design that the building had.

1.2. Architectural patterns theory from Cristopher Alexander theory of language patterns

In this chapter it is introduced how the revolutionary conception of patterns is understood from the different sides, and the capacity to identify its recognition (Sá, 2001); however, considering the architectural pattern language is just a consequence from the pattern language as a tool to discover the hidden possibilities on cities, architecture and others; but, in the disposition to understand how the architecture (buildings) can evidence some patterns based on the definition of "patterns" from the etymology, it refers to distinguish whether it is a patron or a model (Garcia, 2009).

The previous definition about pattern as a model or patron defines an element that seems to belong to the universe and it works into the nature (Alexander, A pattern language, 1977). Through mainly rules that goes above and below, keeping a hierarchic structure of order, the author represent the systematization by going from the bigger to the smaller element on what the author consider connected, redefining the object (design) through the pattern languages, because they can be identifiable.

Moreover, another author Nikos Salingaros developed a graph concept diagram about the pattern behavior and hierarchy explaining different principles such as: Patterns work in a linear structure, patterns help to build other patterns, and that logical structure of logic is the expression for this research considering that the design as an object belongs to the environment, is connected and cannot be isolated as a big system of pattern language embedding the building design. (Salingaros, The Structure of Pattern Languages, 2000).

The pattern language theory demonstrates the particular arrangement from the physical environment and was presented as an archetypal represent a relation with the objects formulating a possibility to understand the patterns' logical connections from the theory of architecture applied to some examples to analyze.

Connecting the statement to the language pattern denoted that the building as a result, is a social representation from the nature, and its function, shape and form, are transformed to be usable by the users in two directions, the first one related how the buildings work as network, and the second one is based on how the building obtain its authenticity and value; further investigation is addressed from the latter, considering that the patterns in the objects, coming from the social function and aesthetic follow the main rule of hierarchy of order that was previously mentioned.

In addition to the capacity to understand, it is presented what the clear difference between shapes and form is; how this intrinsic connection works for this research to understand the final results on the design. Based on Bacon 1974, form can be understood as: “The architectural form is the point of contact between mass and space… Architectural forms, textures, materials, modulation of light and shade, color, all combine to inject a quality or spirit that articulates space (Bacon, 1974). The quality of the architecture will be determined by the skill of the designer in using and relating these elements, both in the interior spaces and in the spaces around buildings”.

In the systematic definition of pattern language, the occupancy of the space is a relevant element because the objects that used this, had a perceptive frame from their form and shape where nature is represented into the physical realm, but here the definition of shape should be clarified due to the form becoming an inner aspect from the shape or otherwise, from that perspective, shape is defined as the essential aspect that comes from the form, holding its appearance in the visual frame, which are the lines and boundaries that define the form (Ching, 2007); for that reason, following the hierarchy of elements, the shape allows the creation of the form and the form hold the shape, totally interconnected, but important to understand considering that the attributes from the building should be readable from one main aspect, in this case, from the shape of building analysis.

As presented as before, architecture is the result of additions and depending on the building conception these additions could be interpreted as patterns that look complex to find, but, at the same should have a simple basis from a starting point, like fractal geometry structures notwithstanding belongs to the theory of chaos at the end that looks complicated when they expand, but maintain the simple structure over their length and scale (Armin Bunde, 1994). From this point of pattern language and fractal organization, it is selected the pattern that provide the path to join with the architecture field through the façade, named as architectural patterns with their own properties and their representation of the elements that compose them.

Before analyzing the building or any façade, is important to mention the conclusion made by Hillier (Hillier, Space is the machine, 1999), which is related to the visible and perceptive frame to the direction of intelligibility that the object could demonstrate, for that reason spatial patterns arise from the physical properties off the building; for example, he mentions a comparison with a Doric column, in which the representation of a structural element with the characteristic style, follows the condition from the logic to use this element connected with the culture and social aesthetic identity properties. In figure no. 3 the relationships are with the understanding of the elements and their significance indifferent to any style but with the intention to create the object identity (Alexander, The Timeless Way of Building, 1979).

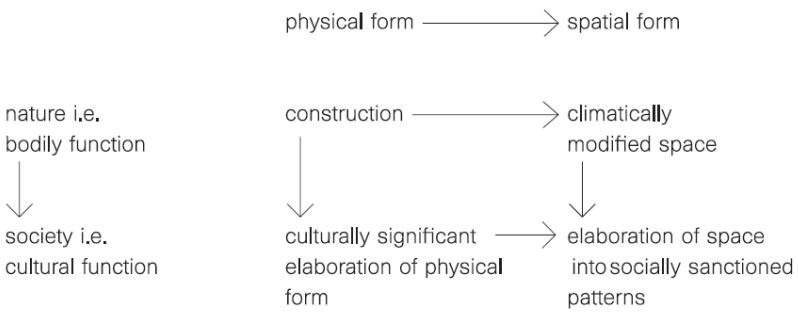


Fig. 3. Nature of buildings (Hillier, Space is the machine, 1999).

In figure 4, the nature of the buildings holds the importance from the social behavior conducting the results of patterns following a deep logic of realization and configuration, summarizing an arrangement of properties represented over the social space, coming to the first point where the building or object started (Hillier, 2011).

Hillier demonstrates that there is no result without the context, people and other external physical factors like the space, are extensions against which the properties of objects were defined, they become a measurable information from the occupancy of the space that relates to their patterns. Furthermore, activities held in the object become themselves spatial patterns and why not into the design features that were mentioned as additions previously, these additions could be represented by different shapes on a building through their facades.

Hillier's investigation provides a better understanding of what type of pattern should be applied in this research, and it is provided an analyzed summary from the 253 pattern languages considering the explanation from C. Alexander, from which it is selected the most accurate to the scope of this research.

Table 1. A Pattern language structure (Alexander, A pattern language, 1977).

TOWNS	Region (Area)	1. Independent regions	■	BUILDINGS	Group of buildings: height, number of buildings, entrances, main parking and lines of movement through the complex	95. Building complex	■
	Each region -› regional policies -› protect the limits from the cities	2. Towns distribution				96. Number of stories	
		3. City country fingers	■			97. Shielded parking	
		4. Agricultural valleys				98. Circulation realms	■
		5. Lace of country streets	■		Local shops & gathering places	99. Main building	■
		6. Country towns				100. Pedestrian street	■
		7. The countryside				101. Building thoroughfare	■
	City policies -› formation of major structures	8. Mosaic of subcultures				102. Family of entrances	■
		9. Scattered work				103. Small parking lots	■
		10. Magic of the city	■		Position of individual buildings on the site, within the complex, one by one, according to the nature of the site: trees, the sun	104. Site repair	■
		11. Local transport areas	■			105. South facing outdoors	■
	Grass roots -› two levels of self-governing communities (identifiable places)	12. Community of 7000				106. Positive outdoor space	■
		13. Subculture boundary				107. Wings of light	■
		14. Identifiable neighborhood	■			108. Connected buildings	■
		15. Neighborhood boundary	■			109. Long thin house	
	Connect communities -› organic network growth	16. Web of public transportation	■		Lay out from the entrances, the gardens, courtyards, roofs, and terraces: shape both the volume of fhe buildings and the volume of the space between the buildings -› indoor space and outdoor space in harmony	110. Main entrance	■
		17. Ring roads	■			111. Half-hidden garden	
		18. Network of learning				112. Entrance transition	
		19. Web of shopping				113. Car connection	
		20. Mini-buses				114. Hierarchy of open space	■
	Community and neighborhood policy -› order and rules	21. Four-story limit	■			115. Courtyards which live	■
		22. Nine per cent parking				116. Cascade of roofs	
		23. Parallel roads	■			117. Sheltering roof	■
		24. Sacred sites				118. Roof garden	
		25. Access to water			Buildings & outdoor -› paths and squares between the buildings	119. Arcades	
		26. Life cycle	■			120. Paths and goals	■
		27. Men and women	■			121. Path shape	
	Formation of local centers	28. Eccentric nucleus	■			122. Building fronts	■
		29. Density rings	■			123. Pedestrian density	■
		30. Activity nodes	■			124. Activity pockets	■
		31. Promenade	■			125. Stair seats	
		32. Shopping street	■			126. Something roughly in the middle	
		33. Night life	■		The movement -› connecting the spaces in the gradients	127. Intimacy gradient	■
		34. Interchange	■			128. Indoor sunlight	
	Growth of housing in the form of clusters -› face-to-face human groups	35. Household mix	■			129. Common areas at the heart	■
		36. Degrees of publicness	■			130. Entrance room	
		37. House cluster				131. The flow through rooms	
		38. Row houses				132. Short passages	
		39. Housing hill				133. Staircase as a stage	
		40. Old people everywhere	■			134. Zen view	
	House clusters -› centers -› boundaries between neighborhoods -› work communities	41. Work community	■			135. Tapestry of light and dark	
		42. Industrial ribbon	■		Development of the most important areas and rooms for a house	136. Couple's realm	
		43. University as a marketplace				137. Children's realm	
		44. Local town hall	■			138. Sleeping to the east	
		45. Necklace of community projects	■			139. Farmhouse kitchen	
		46. Market of many shops			From inside to outside, treating the edge between the two as a place in its own right -› making human details	140. Private terrace on the street	■
		47. Health center				141. A room of one's own	
		48. Housing in between	■			142. Sequence of sitting spaces	■
	House clusters and work communities -› local road and path network-› grow informally	49. Looped local roads				143. Bed cluster	
		50. T junctions				144. Bathing room	
		51. Green streets	■			145. Bulk storage	
		52. Network of paths and cars	■		From inside to outside for offices, workshops, and public buildings	146. Flexible office space	■
		53. Main gateways	■			147. Communal eating	
		54. Road crossing	■			148. Small work groups	■
		55. Raised walk				149. Reception welcomes you	■
		56. Bike paths and racks	■			150. A place to wait	■
		57. Children in the city	■		Arrangement of the gardens & places in the gardens	151. Small meeting rooms i	■
	Communities and neighborhoods -› public open land -› leisure	58. Carnival				152. Half-private office	■
		59. Quiet backs			Small outbuildings -› independent from the main structure -› access from the upper stories to the street and gardens	153. Rooms to rent	
		60. Accessible green	■			154. Teenagers Cottage	
		61. Small public squares	■			155. Old age cottage	
		62. High places	■			156. Settled work	
		63. Dancing in the street	■			157. Home workshop	■
		64. Pools and streams				158. Open stairs	■
		65. Birth places				159. Light on two sides of every room	
		66. Holy ground				160. Building edge	■
	House cluster and work community -› common land -› local needs	67. Common land	■			161. Sunny place	■
		68. Connected play	■			162. North face	■
		69. Public outdoor room	■			163. Outdoor room	
		70. Grave sites				164. Street windows	■
		71. Still water				165. Opening to the street	■
		72. Local sports				166. Gallery surround	■
		73. Adventure playground				167. Six-foot balcony	
		74. Animals				168. Connection to the earth	■
	Common land, clusters, and work communities -› independent social institutions: families, workgroups and gathering places	75. The family				169. Terraced slope	
		76. House for a small family				170. Fruit trees	
		77. House for a couple				171. Tree places	■
		78. House for one person				172. Garden growing wild	
		79. Your own home				173. Garden wall	
	Workshops, offices and children's learning groups:	80. Self-governing workshops and offices	■			174. Trellised walk	
		81. Small services without red tape	■			175. Greenhouse	
	Group of patterns overall	82. Office connections	■			176. Garden seat	
		83. Master and apprentices				177. Vegetable garden	
		84. Teenage society	■			178. Compost	
		85. Shopfront schools			Inside of the building add the necessary minor rooms and alcoves -› main rooms	179. Alcoves	
		86. Children's home				180. Window place	
		87. Individually owned shops				181. The fire	
		88. Street café				182. Eating atmosphere	
		89. Corner grocery				183. Workspace enclosure	■
		90. Beer hall				184. Cooking layout	
		91. Traveler's inn				185. Sitting circle	
		92. Bus stop	■			186. Communal sleeping	
		93. Food stands				187. Marriage bed	
		94. Sleeping in public				188. Bed alcove	

BUILDINGS		189. Dressing room		CONSTRUCTION	Positions for openings-the doors and windows-and frame these openings	221. Natural doors and windows	■
	Shape and size of rooms and alcoves to make them precise and buildable:	190. Ceiling height variety	■			222. Low sill	
		191. The shape of indoor space				223. Deep reveals	
		192. Windows overlooking life	■			224. Low doorway	
		193. Half-open wall				225. Frames as thickened edges	
		194. Interior windows			Subsidiary patterns	226. Column place	
		195. Staircase volume				227. Column connection	
		196. Corner doors				228. Stair.vault	
	Walls Depth	197. Thick walls	■			229. Duct space-	■
		198. Closets between rooms				230. Radiant heat	■
		199. Sunny counter	■			231. Dormer windows	
		200. Open shelves				232. Roof caps	■
		201. Waist-high shelf			Surfaces and indoor details	233. Floor surface	■
		202. Built-in seats				234. Lapped outside walls	■
		203. Child caves				235. Soft inside walls	
		204. Secret place				236. Windows which open wide	■
CONSTRUCTION	Philosophy of Structure	205. Structure follows social spaces	■			237. Solid doors with glass	
		206. Efficient structure	■			238. Filtered light	■
		207. Good materials	■			239. Small panes	■
		208. Gradual stiffening	■			240. Half-inch trim	
	Structural layout	209. Roof layout	■		Outdoor details to finish the outdoors as fully as the indoor spaces	241. Seat spots	
		210. Floor and ceiling layout	■			242. Front door bench	
		211. Thickening the outer walls	■			243. Sitting wall	
		212. Columns at the corners				244. Canvas roofs	
		213. Final column distribution				245. Raised flowers	
	Start erecting the main frame of the building according to the layout of these stakes	214. Root foundations	■			246. Climbing plants	
		215. Ground floor slab				247. Paving with cracks between the stones	
		216. Box columns				248. Soft tile and brick	
		217. Perimeter beams			Ornament and light and color	249. Ornament	■
		218. Wall membranes	■			250. Warm colors	■
		219. Floor-ceiling vaults	■			251. Different chairs	
		220. Roof vaults				252. Pools of light 5	
						253. Things from your life	■

In table 1, is notable that from the perspective of Alexander, the patterns are structured in three main columns, those which belong to the towns, similar to an urban point of view; the buildings, similar to the objects (related to this research); and the construction, that is related how the logic of rising a building follows the hierarchy of patterns.

Many of the patterns in each section represent an important role in the sense of designing an object in the context, but considering the scope of this research, for this analysis, it is needed to focus on those which belong to the buildings or that can have properties to explore in one element from the building; for that reason, me marked in black those which can have an influence in the investigation in view of the path through the façade analysis.

Table 2. Town pattern scoring selection by author

Pattern Classification	Pattern Number	Influence the building design in their context		Influence the building façade elements such as windows, doors, and other ones		Influence the building composition like hierarchy, contrast, rhythm, and other ones		Influence the building aesthetics façade analysis		Total Value	
		Score: 1		Score: 2		Score: 3		Score: 4		Base score: 10	
		Y	N	Y	N	Y	N	Y	N	Y	N
TOWNS	1	1	0	0	2	0	3	0	4	1	9
	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	1	0	0	2	0	3	0	4	1	9
	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	1	0	0	2	0	3	0	4	1	9
	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	0	1	2	0	0	3	0	4	2	8
	11	1	0	0	2	0	3	0	4	1	9
	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	1	0	0	2	0	3	0	4	1	9
	14	1	0	2	0	0	3	0	4	3	7
	15	1	0	2	0	0	3	0	4	3	7
	16	1	0	0	2	0	3	0	4	1	9
	17	1	0	0	2	0	3	0	4	1	9
	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	1	0	2	0	0	3	0	4	3	7
	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	23	1	0	2	0	0	3	0	4	3	7
	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	26	1	0	0	2	0	3	0	4	1	9
	27	1	0	0	2	0	3	0	4	1	9
	28	1	0	0	2	0	3	0	4	1	9
	29	1	0	0	2	0	3	0	4	1	9
	30	1	0	0	2	0	3	0	4	1	9
	31	1	0	0	2	0	3	0	4	1	9
	32	1	0	0	2	0	3	0	4	1	9
	33	1	0	0	2	0	3	0	4	1	9
	34	1	0	0	2	0	3	0	4	1	9
	35	1	0	2	0	0	3	0	4	3	7
	36	1	0	2	0	0	3	0	4	3	7
	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	40	1	0	0	2	0	3	0	4	1	9
	41	1	0	0	2	0	3	0	4	1	9
	42	1	0	0	2	0	3	0	4	1	9
	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	44	1	0	0	2	0	3	0	4	1	9
	45	1	0	0	2	0	3	0	4	1	9
	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	48	1	0	2	0	0	3	0	4	3	7
	49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	51	1	0	0	2	0	3	0	4	1	9
	52	1	0	0	2	0	3	0	4	1	9
	53	1	0	0	2	0	3	0	4	1	9
	54	1	0	0	2	0	3	0	4	1	9
	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	56	1	0	0	2	0	3	0	4	1	9
	57	1	0	0	2	0	3	0	4	1	9
	58	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	59	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	60	1	0	0	2	0	3	0	4	1	9
	61	1	0	2	0	0	3	0	4	3	7
	62	1	0	0	2	0	3	0	4	1	9
	63	1	0	0	2	0	3	0	4	1	9
	64	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	65	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	67	1	0	2	0	0	3	0	4	3	7
	68	1	0	2	0	0	3	0	4	3	7
	69	1	0	2	0	0	3	0	4	3	7
	70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	71	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	73	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	74	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	76	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	78	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	79	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	80	1	0	2	0	0	3	0	4	3	7
	81	1	0	0	2	0	3	0	4	1	9
	82	1	0	2	0	0	3	0	4	3	7
	83	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	84	1	0	2	0	0	3	0	4	3	7
	85	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	87	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	92	1	0	0	2	0	3	0	4	1	9
	93	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	94	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3. Building pattern scoring selection by author

Pattern Classification	Pattern Number	Influence the building design in their context		Influence the building façade elements such as windows, doors, and other ones		Influence the building composition like hierarchy, contrast, rhythm, and other ones		Influence the building aesthetics façade analysis		Total Value	
		Score: 1		Score: 2		Score: 3		Score: 4		Base score: 10	
		Y	N	Y	N	Y	N	Y	N	Y	N
BUILDINGS	**95**	**1**	**0**	**2**	**0**	**0**	**3**	**4**	**0**	**7**	**3**
	96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	97	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	98	1	0	0	2	0	3	0	4	1	9
	99	**1**	**0**	**2**	**0**	**0**	**3**	**4**	**0**	**7**	**3**
	100	1	0	0	2	0	3	0	4	1	9
	101	1	0	2	0	0	3	0	4	3	7
	102	1	0	2	0	0	3	0	4	3	7
	103	1	0	0	2	0	3	0	4	1	9
	104	1	0	0	2	0	3	0	4	1	9
	105	1	0	2	0	0	3	0	4	3	7
	106	1	0	2	0	0	3	0	4	3	7
	107	1	0	2	0	0	3	0	4	3	7
	108	1	0	2	0	0	3	0	4	3	7
	109	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	110	1	0	0	2	3	0	0	4	4	6
	111	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	112	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	113	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	114	1	0	0	2	3	0	0	4	4	6
	115	1	0	2	0	0	3	0	4	3	7
	116	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	117	1	0	0	2	3	0	0	4	4	6
	118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	119	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	120	1	0	2	0	0	3	0	4	3	7
	121	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	122	1	0	0	2	3	0	0	4	4	6
	123	1	0	0	2	0	3	0	4	1	9
	124	1	0	0	2	0	3	0	4	1	9
	125	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	126	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	127	1	0	2	0	0	3	0	4	3	7
	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	129	1	0	2	0	0	3	0	4	3	7
	130	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	131	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	132	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	133	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	134	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	135	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	136	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	137	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	138	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	139	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	140	1	0	2	0	0	3	0	4	3	7
	141	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	142	1	0	2	0	0	3	0	4	3	7
	143	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	144	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	145	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	146	1	0	2	0	0	3	0	4	3	7
	147	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	148	1	0	2	0	0	3	0	4	3	7
	149	1	0	2	0	0	3	0	4	3	7
	150	1	0	2	0	0	3	0	4	3	7
	151	1	0	2	0	0	3	0	4	3	7
	152	1	0	2	0	0	3	0	4	3	7
	153	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	155	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	156	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	157	1	0	2	0	0	3	0	4	3	7
	158	1	0	2	0	0	3	0	4	3	7
	159	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	160	1	0	2	0	0	3	0	4	3	7
	161	1	0	2	0	0	3	0	4	3	7
	162	1	0	2	0	0	3	0	4	3	7
	163	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	164	1	0	2	0	0	3	0	4	3	7
	165	1	0	2	0	0	3	0	4	3	7
	166	1	0	2	0	0	3	0	4	3	7
	167	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	168	1	0	0	2	0	3	0	4	1	9
	169	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	170	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	171	1	0	2	0	0	3	0	4	3	7
	172	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	173	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	174	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	175	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	176	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	177	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	178	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	179	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	180	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	181	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	182	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	183	1	0	2	0	0	3	0	4	3	7
	184	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	185	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	186	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	187	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	189	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	190	1	0	0	2	3	0	0	4	4	6
	191	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	192	1	0	2	0	0	3	0	4	3	7
	193	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	194	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	195	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	196	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	197	1	0	0	2	3	0	0	4	4	6
	198	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	199	1	0	2	0	0	3	0	4	3	7
	200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	201	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	202	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	203	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	204	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4. Construction pattern scoring selection by author

Pattern Classification	Pattern Number	Influence the building design in their context		Influence the building façade elements such as windows, doors, and other ones		Influence the building composition like hierarchy, contrast, rhythm, and other ones		Influence the building aesthetics façade analysis		Total Value	
		Score: 1		Score: 2		Score: 3		Score: 4		Base score: 10	
		Y	N	Y	N	Y	N	Y	N	Y	N
CONSTRUCTION	205	1	0	0	2	3	0	0	4	4	6
	206	1	0	0	2	0	3	0	4	1	9
	207	1	0	0	2	0	3	4	0	5	5
	208	1	0	0	2	0	3	0	4	1	9
	209	1	0	0	2	3	0	0	4	4	6
	210	1	0	0	2	3	0	0	4	4	6
	211	1	0	0	2	0	3	0	4	1	9
	212	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	213	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	214	1	0	0	2	0	3	0	4	1	9
	215	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	216	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	217	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	218	1	0	0	2	3	0	0	4	4	6
	219	1	0	0	2	3	0	0	4	4	6
	220	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	221	1	0	2	0	0	3	0	4	3	7
	222	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	223	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	224	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	225	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	226	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	227	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	228	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	229	1	0	2	0	0	3	0	4	3	7
	230	1	0	2	0	0	3	0	4	3	7
	231	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	232	1	0	0	2	3	0	0	4	4	6
	233	1	0	0	2	3	0	0	4	4	6
	234	1	0	0	2	3	0	0	4	4	6
	235	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	236	1	0	2	0	0	3	0	4	3	7
	237	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	238	1	0	2	0	0	3	0	4	3	7
	239	1	0	2	0	0	3	0	4	3	7
	240	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	241	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	242	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	243	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	244	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	246	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	247	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	249	**1**	**0**	**2**	**0**	**0**	**3**	**4**	**0**	**7**	**3**
	250	1	0	0	2	0	3	4	0	5	5
	251	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	252	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	253	1	0	0	2	0	3	0	4	1	9

It was taken from the table No. 1 the pattern list and it was evaluated with 4 criteria which contain yes and no option to scored: the first one was about the influence from the design and the surroundings due to not all the patterns had the possibility to generate an object without the integration on the place where they belong creating an isolated and unconnected building, from that perspective it was scored by the value of 1; the second was the influence from windows, doors, and other elements that belong to the building façade this is because some pattern could conditionate the arrangement of these elements changing the hole visual frame of any façade, the value was set under 2; the third score was the influence over the composition due major elements shape the main features from the buildings and is a relevant characteristic for the investigation, the score for this criteria was under 3; and the last one was the influence from the pattern to perform a further analysis from the aesthetics considering that the previous mentioned generate a compilation of element that create the final façade perception, the score to this criteria was set under 4. All the mentioned before, generates the path to the patterns study, the total value was from 0 to 10 were the last one is the highest score for taking in consideration a detailed analysis.

1.2.1. Building patterns

Building patterns are the representation of those which can be used in the design process or being localized in any building part of its shape. This pattern explains the aspect of network interaction from individual objects or from complex ones. From the individual houses to collective houses, one important feature is the understanding of the hierarchy presented by Alexander (Alexander, A pattern language, 1977). In a simple understanding layer, one simple object derives into a more elaborated one.

This pattern shows the relation with the quantification numbers of some features, like the connection this had with the surrounding area and the building properties; the disposition that it should have; and the elements that compose and condition them, such as the nature, the comfort, the connectivity, and the emotions.

With the buildings' patterns is easy to build or recognized the result of the building through its social effect of knowledge, interpreting that the exterior is the result of this interior space definition, and aligning this definition with this research means that the exterior information from the building could be from the interior. For example, if the main entrance for the building is a space connecting two wings, then these became an important element that could be easily interpreted; And imagine that into the wings, rooms take place, those rooms then represent a natural rhythm through each wing; consequently, the information that the building could have under its arrangements will lead to summarize the effects into the attributes like symmetry, hierarchy, or rhythm.

1.2.1.1. Building Complex

Building complex are related with this research to understand the components that condition the disposition on the space, but moreover about the occupancy of the space and the logic on how these social elements are shaping the settlement of this type of building or entity.

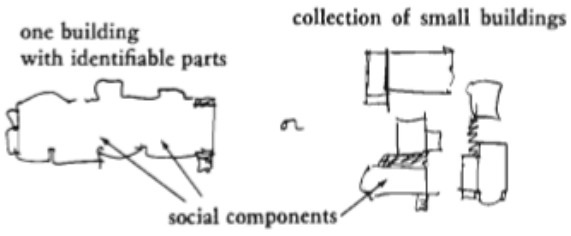


Fig. 4. Building complex social components (Alexander, A pattern language, 1977)

At this stage, the author mentioned about the building intelligibility that comes from the organization layout, explaining by these social factors the components around them. As a result, he mentions all the characteristics that each element has in this type of classification. In this research, this social organization from the buildings is a representation of layout disposition; for example: linear, radial, or segmented, these settlements had an impact related with the object because the focus of this research is directed with the facades, and this one belongs to particular layouts from different groups of buildings or single ones.

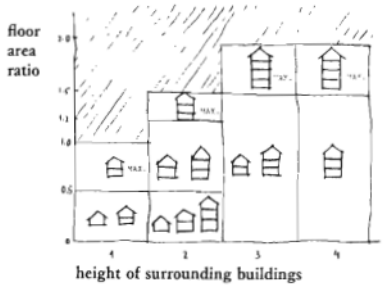


Fig. 5. Building complex height (Alexander, A pattern language, 1977)

In figure 5, from sketches is noticeable how the height configures the visual frame concerned about the proportion following a pattern related with the social needs between the floor area ratio (living) and the proportion of them; therefore, this pattern demonstrates two possible attributes over a façade, the capacity of rhythm and the capacity to demonstrate a building scale on term of proportion.

1.2.1.2. Main Building

Already presented in the beginning as the author mentioned from the complex building; it is selected the building properties, and some features presented by Alexander will be mentioned. In the beginning it was concluded that the connection with the environment leads to understand the main building, and as a result is seen roofs as an important element in the building, representing the social behavior.

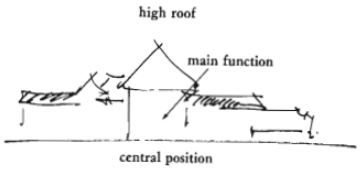


Fig. 6. Main building high (Alexander, A pattern language, 1977)

Entrance acquires a hierarchy position based in figure no. 6; these attributes should be distinguished in the research over other example analysis buildings.

1.2.2. Construction patterns

Nature always shows and follows some patterns defined by sequence of procedures. In this part, the elements that compose the building play an important role in the pattern logic sequence, as a matter of fact to create a building, some steps should be followed.

For this research topic is important to mention that nature in the environment present a proper pattern on the buildings with their own hierarchy towards the floors plan distribution, from the layout conception to the building part, where the columns and other elements like windows and doors, raise the construction of the building.

For that reason, patterns address the path in which the finishing part is built and compose it, creating the ornamentation and details that give the personality to the building.

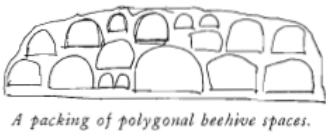


Fig. 7. Construction patterns follow social nature information. Cristopher Alexander.

1.2.2.1. Ornaments

Users have the basic instinct to decorate, and decoration turns into complex forms giving properties to the buildings. This pattern belongs to the construction because is a final pattern over the pattern path that relate to the building attributes proving their readability and their property of intelligibility, going forward of its function.

With this pattern, the object instead of a building or architecture, is surrounded by the natural inner structure between boundaries, this boundary will define the scope of this element's growth; for example, if having the same example of the main entrance in the center and two wings, both on each side, and rooms repeated into the wings, ornaments flourish over the main building revealing the social power from the spaces.

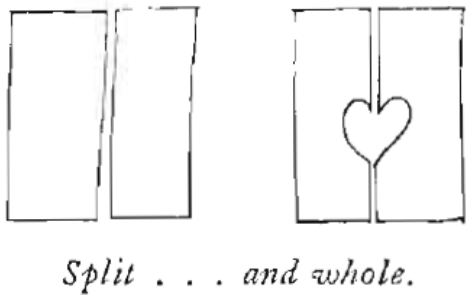


Fig. 8. Ornaments patterns (Alexander, A pattern language, 1977).

The previous picture explains the interpretation from of intelligibility considering the interpretation of the shape, where the same line acquires another identity due to the heart shape.

1.3. Paradigms in architecture influencing the theory of patterns in architecture

After reviewing C. Alexander pattern theory (Alexander, A pattern language, 1977), there is a foundation to connect with the studies of paradigms; because theory of patterns should be indistinct of the style, and the architectonic building styles is attached to the world of paradigms. The Paradigm is a term that is always discussed through many fields concerning about how it is understand it and observed?, but certainly, it is defined by the conception of the basic (ideas), for that reason, the paradigm definition from the Greek and Latin describes the following: "para-" means "beside" and "-Deiknynai" means display; but, in Latin was used to attribute "a model or pattern" (MacMillanDictionary, 2019).

This conception of paradigm is mentioned in two different ways, one from the side of the investigation and other from the result of the realization. In the first, three principles can be mentioned: postpositivist, naturalistic and emancipatory; each of them has different scopes in the procedure to develop research validation and elaboration, for this research topic the closest one is the post positivist, contemplating that the aim considers the reality as main fact, and the production of knowledge should be based on objectivity focused on experimentation that demonstrate results in quantitative assets. (Sattrup, 2012) And, in the last two are most enclosed to take different social branch, ethnic branch and in terms of this investigation are not directly focused.

In respect of the Latin definition previously explained, as a first statement in this research the focus is on the paradigms that are more interconnected with "the architecture field" and with this research topic being: Classicism, Modernism, CAD, and, patterns' paradigms, with the objective to extract further understanding from these insights and collect important features for this research.

1.3.1. Paradigm of classicism

The Classicism covers the period from 1750 until 1830 (Britannica, 2020) intended to be the significance of true style in the way to recreate and re-interpretate the classical architecture (Greek). In this case, it will be mentioned how this paradigm had a strong impact on this research, considering that the aesthetics and composition method of designing started by the guidelines of classical architecture.

The classicism had a remarkable signature coming from past centuries and in specific about the Vitruvius essay which is divided into 10 parts or books (Ingrid D. Rowland, 2001). Vitruvius mentions different rules to design a building and other object, but for this research it will be referred to one of his books (Vitruvius, 1914). In the first book where he set the 3 main principles for designing any element: Firmitas, Utilitas and Venustas, he explained in each the relation in the design stage, from a humanization analogue characteristic point of view.

These three main rules according to the execution of any object demonstrates the logic behind the materials considering for example, how the use of the roman mortar allows them to rearrange their spaces besides their necessities, in multiples configuration but maintaining the importance of beauty as an art masterpiece through composition statements like symmetry. For Vitruvius symmetry in this case played an important role from the aesthetic and at the same time inherited more components mentioned on his essay, for instance: Order, disposition, proportion, symmetry, décor, and distribution (Economou, 2018).

Nevertheless, is important to illustrate these examples from Vitruvius essays since it generates a foundation on how the level of applied aesthetics was stablished and recreated along the periods:

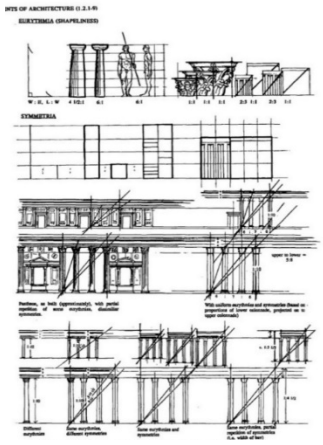


Fig. 9. Elements of architecture (Vitruvius, 1914).

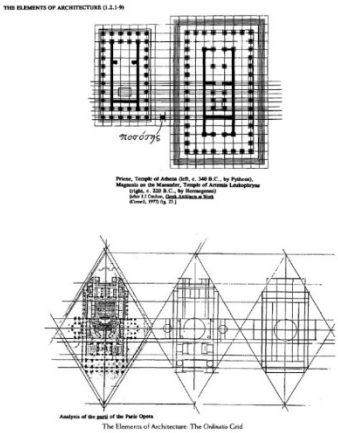


Fig. 10. Symmetry and proportion from nature (Vitruvius, 1914)

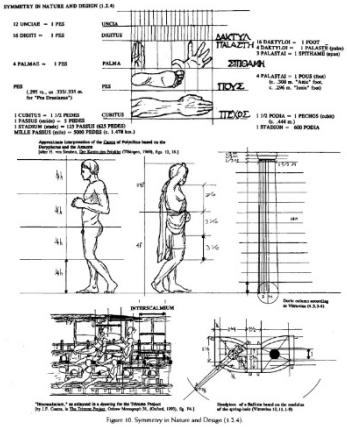


Fig. 11. The grid dispostion (Vitruvius, 1914)

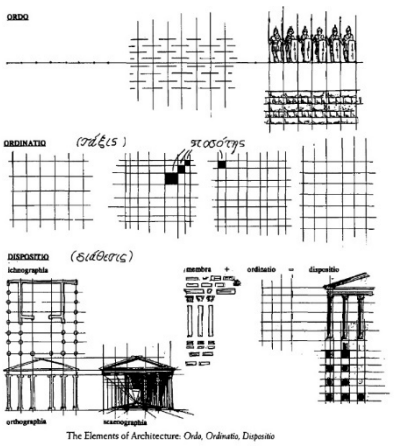


Fig. 12. Ordo, ordinatio and dispositon (Vitruvius, 1914)

Figure 9 shows the orthogonal disposition of elements based on a grid with same space between elements reflected in the structure and elevations, this grid provided a simple disposition of elements based on the building type, meaning that the grid provided the sufficient plasticity to set columns, foundations, or other building element in the buildings.

The figure 10 the example provided an orthogonal solution even though a diamond form allows to construct a complex building, rather than the form. It can be appreciated on the Vitruvius conception that to set the layout of the buildings is the rationality of the lines and spacing, this one with one important construction element that is based on “the nature”.

In figure 11 the proportion represents a notable element in the elevation structure of columns or facades, demonstrating the basic grid logic like the layouts previously mentioned. It is important to mention that this grid and disposition provide a pattern to follow and take into consideration for this research further analysis on the façade’s architectural patterns, keeping in mind that this is the theory of architecture applied to this examples.

Finally, figure 12 provides the most important aspect from the applied of theory of architecture that it has been mentioned by Hillier (Hillier, Space is the machine, 1999). Him and Salingaros on their analysis and correspondence to the nature of the element in which this analogue interpretation from the human body provided the elements that will be repeated over the centuries to hold and maintain the harmony between the buildings, but at the same time this is translated on the purpose of this research, involving that this presence or lack of nature over some buildings can provide a better aesthetic response, taking in account that the examples that should be analyzed belongs to this paradigm.

With the paradigm of classicism major attributes on the facades are mentioned in the book “poetics of order” from the author Lefaivre, where he mentions and describes that the settlement of symmetry in architecture was under the scientific point of view observing nature and the arrangement of elements in the surroundings, remarking the position of the classicism in terms of composition such as symmetry, balance, focus, finality, proportion and hierarchy (Lefaivre, 1986), combined together in the generation of different buildings and architectural elements based on their purpose, becoming the first cannon of aesthetics strongly connected with Vitruvius’ essay publication about the ten books of architecture.

In consequence, classical architecture uses contour patterns and ornaments in a limited and systematic manner, for example, the Doric columns giving the shape to the members in an architectural scale to form a sense of architectural modality creating the possibility of a gradual system of hierarchical composition; besides the author mentions that he called the already created order, “pattern ordered by taxis (arrangement)”. The rest is a conclusion of metric patterning, known to him as classical poetics or symmetry.

Classicism paradigm not only create the way of how the application of theory is understood, in fact Eismann already explained in his essay about the capability to identify a reader that has the capacity to make understandable the not classical architecture known as Classicism (Eisenman, 1984), giving the self-implication that architecture is a readable language, for that reason in this research it will be analyzed this paradigm in order to extract the nature language from classicism building’s façade.

1.3.2. Paradigm of modernism

In the previous part it was mentioned the impact from the non-classical architecture as Eismman mentioned, but that nature evolution from architecture as a field has been advancing through different periods, simultaneously with other areas. Modernist Paradigm, whereas from the last mid-twenty century appears to challenge the way on how the architecture was made, coming to reject the classicism and seeking a way to simplify forms and shapes, changing the conception of new aesthetics aims and at the same time the way of how it is appreciated (Lu, 2010). This paradigm is important to mention considering that the modernism maintained its relationship with the design principles, less obvious but with deeper logic (Danius, 2019).

This new paradigm became stronger after the WWII, as cities and buildings were destroyed and the necessity to rebuild them connects with the new economy influences promoting barriers between poverty and industrialization. All of these and other factors concerning to this paradigm, but not essential for this investigation raised to build this paradigm for over more than 40 years with main fundaments as Karacay mention on her article (Hatice Karaçay ÇAKMAK, 2007); For example: The individuals aim to increase its own interest, this interest should be regulated by global economy. Economy development will have an impact on the society and individuals but at the end this new perspective came with the change to obtain “development”.

The end or negation of aesthetics was also mentioned by Eismann in his publication, he explains that the modern paradigm tried to re-shift the reality, like another positivist philosophy reinterpretation but without decoration or décor as Vitruvius called (Vitruvius, 1914); however, this new expression to demonstrate the real function of the building changes; for example, a column that has a capitel modernly rebuilt without the decoration leaving the pure aesthetic cylinder form. Behind this new way to conceive and argue about how modern architecture should be represented rather to consider classicism as a crime as Adolf Loss mentioned on his book (Loos, 2019).

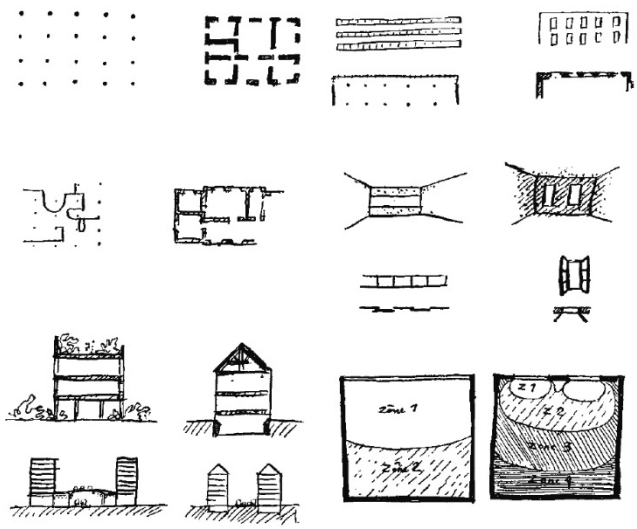


Fig. 13. Five principles of modernism (Corbusier, 1985).

Related to architecture this paradigm could be resumed in the principles mentioned by the architect Charles-Édouard Jeanneret, he proposed over his interpretation the modernism frame on the magazine L'Esprit Nouveau, this proposal encloses a concept of functionality and pureness through a schematic point of view these being: Pilotis, free ground plan, free façade, horizontal window and roof gardens (Corbusier, 1985); from all of them Christian Schulz mentions the process to change nature archetypes in the same of figures like column, arc, tower, etc. Meanwhile, Le Corbusier through his statement about the wisdom role from the volume between shadow and lights, like cubes, cones, spheres, cylinders, etc. He interprets that the shapes are preserved through other purer forms (Norberg-Schulz, 2000).

Figure 13 represent the five principles by Le corbusier in comparison with the Classicism paradigm from a structured pattern layout to seet the interior of important buildings, this example proposed the use of them to set a new layout without boundaries, the linear is a result from the use of the structure enhancing the use of light to create a new connection with the surroundings, the façade avoids the use of ornamentation and the use of garden roof in the top of the building.

It is important to mention how this disruptive period of neglection from the paradigm, fails in the way to avoid the use of theory of architecture. (Hillier, Space is the machine, 1999) Additionally, the natural properties before this paradigm, erased the natural essence in the objects. For this research is important to study the effects of this architecture on the aesthetics interpretation towards its compositional attributes. (Salingaros, Architecture, Patterns and Mathematics, 1999).

1.3.3. Paradigm of CAD

As it is noted paradigms are in constant movement, evolving from styles experimentations seeking a new heuristic path; in general terms, this paradigm started to flourish after the WWII (Edward Bullard, 1975), and it was already standing in the middle of a modernism paradigm. Between that period, economic and technological influences tend to seek a maximization of building production along the expansion of the cities, demanding the construction of new buildings and infrastructure.

This dynamic of acceleration and the development of new technologies after the war influenced by the development of airplanes and cars introduced the possibility to improve the production and optimization through better mathematical systems; in that motion, Pierre Bezier and Paul de Castelju developed the first spine curves system called NURBS, but it was until 1957 that Patrick Hanratty developed PRONTO, used in the united aircraft as the first computer aided design (Peddie, 2013).

The development of hardware and software engaged a flexible strategy to optimize results in the object conception, for instance, the most accurate beginning of this paradigm was under the scope to establish a way to digitize schemes and drawings through the data description language giving a responsive possibility to work with other techniques in the design production, creating a new methodology where the computers provide (Hassan A. Karimi, 2009). Thus, now with the understanding of the CAD paradigm the channel to recreate the space and the objects provide a quantitative result on terms of design production, passing from the mechanic to the digital one.

In the architecture field, it took around 30 years to get familiar with the implementation of CAD as a tool to design, because previously was perceived as an experimentative area; for example, for the Sidney Opera developed in the early 1980 by Jorn Utzon, the CAD tools helped to stablish a different architectural interpretation, marking a tendency on how to resolve complex curve shapes and structural complications in the design (Murray, 2003); another example was for The Gherkin, London developed by Foster and Partners, the CAD simulation helped with the shape analysis to improve the wind fluency through the building. If making a simple comparison, in the first example the solution was provided to resolve technical and constructive problems from the form of the building, and in the second example the solution came from the environment simulation providing the shape result based on data analysis (BBC, www.BBC.com, 2014).

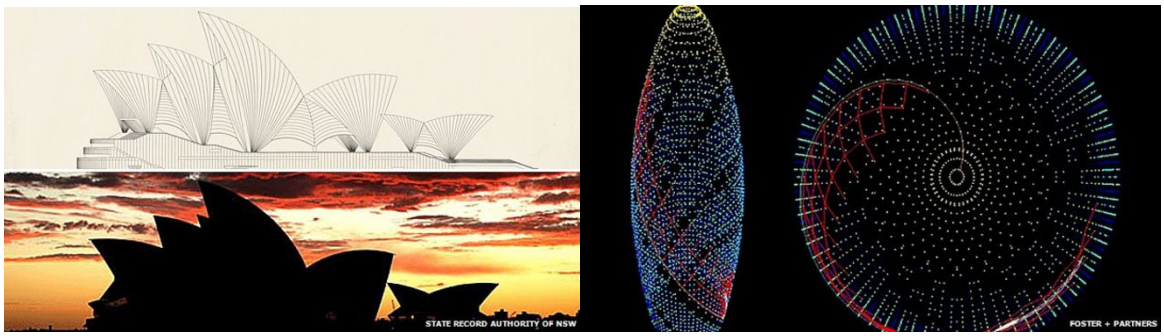


Fig. 14. Left: Sidney, Opera. Right: The Gherkin, London. (BBC, www.BBC.com, 2014)

The change to a digital application in the field of architecture is an aspect that it would be covered under this research, because the application and involvement of CAD tools provide the way and the mechanism to create the pattern parametrization considering the relationship between this paradigm and this investigation that was found in the book "The Digital Turn in Architecture from 1990 to 2010" by Mario Carpio and along with his essays' compilation a sustainable dialogue between many concepts allowed to understand the range of this investigation (Carpio, 2012).

First, he mentioned that in the traditional architecture the perspective of vision and occupancy used a particular spatial typology where the core was the anthropocentric subject and this new digital conception detached that rationalization of space, attracting as a consequence, the term folding space; meaning that this new concept denied the framing of a temporal modulation and at the same time the fold terminology reject the privileges of planimetric projection creating a variable curvature, as a result, it turns into a dislocating vision and the effect from the users are not responsive in the way to understand or interpret the space (Carpio, 2012).

A second statement mentioned with the paradigm shift is about the application results of using CAD, because it questions that using this tool these days is a deeper change in the mental pursue from the architects understanding and concluding the term: nonlinear architecture related with the Eureka moment as an example where spontaneously the self-organization related with the fractal patterns increase the degree of freedom in the design itself that explains that the possibilities in the creation or analysis open a different frame of shapes and forms because the software manages different results with the same input.

Likewise, a third statement over his investigation relies in the insertion of two concepts: the topological architecture and the parametrization as a new style for architecture and urban design. The first one relates the shifting from the classicism geometric substitution form like the square, circle and triangle to the vector, frame and inflection creating a generative dynamic shape that escape from the previous tendency to create and form. The second concept tends to explain the capacity to articulate programmatic complex results; this implementation is argumented by the author as a correlation between elements and subsystems with some concepts, computational skills and tectonic logics increasing the ability to create complex social processes and institution.

The term parametrization is widely defined in 5 concepts where each of them pursue a result:

1. Parametric interarticulation of subsystems, is the relation between one single system and the script element that join other subsystems: for example, the swarm of façade components.
2. Parametric accentuation, is the improvement sense of organic integration as an amplification result rather to an adaptation, providing a richer articulation oriented to make available the visual information.
3. Parametric figuration, is a complex configuration of elements and variables with high figuration-sensitiveness.
4. Parametric responsiveness, it refers to the inbuilt kinetic capacity to respond based on the configuration of pattern occupation seeking a sustainable adaptation.
5. Parametric urbanism-deep relationality, is the relation to study the integration of the evolving built environment.

Parametrization is one result from this paradigm that encourages this research, thus it will be worked with the second concept of parametrization accentuation considering that the patterns are actual attributes that the building inherits. As well, seeking the natural order of these attributes and the exploration to implement them in future objects permit to accentuate the differentiation between the articulation of the attributes.

The path to observe this new interpretation of nature through nonlinear architecture provides the understanding of fractal geometry as the capacity to understand a self-organized pattern in different scales and dimensions through a repetitive expression. The fractal study has helped to explain types of shapes and patterns (Feldman, 2012), however, in the architecture field this geometry fractal delivers a particular visual information from the resources and objects and interpolating the fractal information from buildings (Vaughan, 2013) founding measurements and characteristics into the objects from urban towns and skylines, introducing a wide portfolio of opportunities; for that reason, the fractal analysis could represent a path to this research, considering the potential to represent valuable properties from the compositional attributes (Amal Osama, Fractal geometry in architecture: from formative idea to superficial skin design, 2014).

1.3.4. Paradigm of patterns

Since the modernism started to simplify the aesthetics approach in contrast with the history presets, the conception of aesthetics was conceived in a new way of observation with the objective to enhance the nature (Abbs, 2005), guiding the path to the paradigm shift associated to the paradigm of patterns.

This paradigm is considered by Grabow on his book “The Search for a New Paradigm in Architecture” like a new conception of implication interrelated with the nature and order as a consequence of Alexander’s investigation through the analysis of pattern language (Grabow, 1983), this new conception is relevant to the topic because the comprehension of nature acquires a transcendental importance, demonstrating the theory that the nature’s rules, have their inner hierarchy as an evidence to understand that all objects had the properties of being defragmented or decoded in terms of “patterns” to connect with the human sense and nature itself if there is some remaining.

The inner property from the recodification of patterns presents their own morphology, holding an inner capacity that could be described in geometric properties enclosing in its interior a new conception of beauty from the form with their own aesthetic properties. Accordingly, to the acquisition property from the patterns to beauty perception, allows to connect with the world of mathematics producing a relationship with logic (Alexander, A pattern language, 1977), even these properties went with the correlation between geometry and color, like a similar path done by Le Corbusier on his projects concerning about the contrast with light and shadows. (Jeanneret, 1980).

Even then, Le Corbusier understood in a simplified way the conception of patterns using the Modulor and its relationship in his book Modulor 1 and 2 from the major object went to the detail of the furniture using his own scale measurement tool; Alexander did it through his research with the patterns language addressing the result that this new aesthetic approach should be investigated as a scientific problem comparable as a set of rules (Grabow, 1983).

At this point for this topic is relevant to recognize that the nature through its patterns have the capacity to express a new beauty conceptualization using the mathematical insight, and this new paradigm allows to decode the perception of aesthetics, because is connected with the nature and as a consequence it can be recognized that the actual process of design on this 20th century is experiencing two directions, one associated with the production and the other with the interpretation; therefore, this trending method is affecting the users readability. At that point, the studies by Salingaros mentioned as a prior conclusion that people are losing the humanity sense in the design production from the spatial and formal assets making "traumatic" this new understanding that the design field is taking (Salingaros, Design Patterns & Living Architecture, 2017). At the end, the pattern language becomes aesthetical appealing considering that the universe is inherent in the physical structure and is contradictory that today's modern architecture is not concerned with this distinction of humanity, resulting in that this new paradigm understanding open the gate to measure nature and as a result the object (design).

1.4. Case studies of façade analysis implementing mathematical methods

Case studies will help to understand the application and exploration from the theory related with all the term and objects for this research; anteriorly, it was explained from the last paradigm an important concept as a guidance from this main paradox. In this part, it is analyzed the definitions and the implications; for example, the term parametrization as a crucial definition which leads the path of how these patterns can be measured, its defined based on the dictionary as: to express in terms of parameters. (Merriam-Webster, 2019).

In this stage a question is made: how the parametrization works for this topic? First, it is needed to translate the properties from the object that sometimes is abstract and place it in an intelligibility frame from the space, that implies that is needed to apply the knowledge from the theory of architecture to the pattern's theory with the purpose to build the model that will help create the configuration of patterns and parametrization itself.

From the patterns, it is important to recognize the representation of each element, as it was explained before they have a spatial relationship, over the surface of the attributes in the object, interpreting the relationship from the shape or from the form, this information is addressed using the mathematical input, considering that the uncertainty from the elements should be taken and represented, as it was mentioned, architecture is the result of the nature and sometimes patterns from nature are not readable, but can be identified and they require a certain level of knowledge and reflection from the ground of experience.

Many sources present different proposals to make the patterns recognizable, addressing the aesthetic and the interest to measure through proposals of numbers a further analysis for the patterns, taking in consideration that a pattern is an element (symbol, pixel, or other feature in the universe) (Klinger, 1999).

After the previous argumentation, the intention of this parametrization is to follow the logic order from the nature, throw the object and throw the design, revealing the underlayers that all of them have, in some cases obvious from the nature and other ones not; for that reason, the migration of analytic information will come from the mathematics, considering that the numbers as a property create and determinate beyond the quantitative order of them, the weight, and the most important hierarchy after addition, multiplication, etc. (Yang Kuang, 2012) in that way, quantifying the hierarchy from the buildings or from the design.

To understand how the parametrization can reveal the information from the building, it is presented the Salingaros interpretation image content (Salingaros, The Structure of Pattern Languages, 2000):

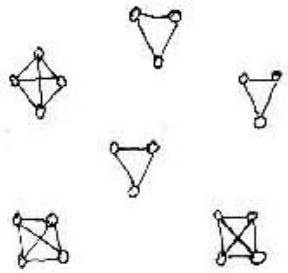


Fig. 15. Individual pattern groups form six higher-level patterns having additional properties. (Salingaros, The Structure of Pattern Languages, 2000).

Patterns can be identified with nodes in a graph, and the graphs are connected by edges in different lengths.

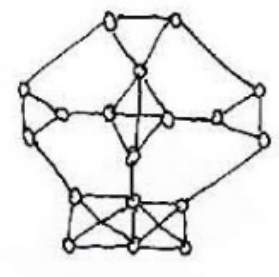


Fig. 16. Further connections organize the patterns in Figure 16 into a pattern on the next higher level. New properties of the whole correspond to new symmetries. (Salingaros, The Structure of Pattern Languages, 2000)

A coherent combination of patterns will form a new, higher-level pattern that possesses additional properties.

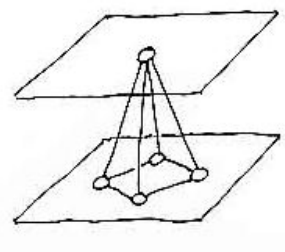


Fig. 17. Hierarchical connections show how patterns on higher levels depend on those on lower levels. (Salingaros, The Structure of Pattern Languages, 2000).

The combination of patterns acting on a smaller level of scale acquire new and unexpected properties that do not present in the constituent patterns, and these are expressed in a higher-level pattern.

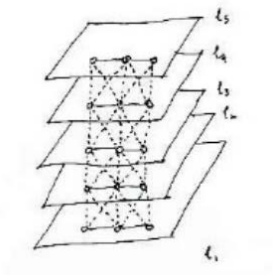


Fig. 18. Patterns on one level combine to help define a new pattern on a higher level. (Salingaros, The Structure of Pattern Languages, 2000)

Many failures in describing a complex system are due to not allowing for enough levels. A gap between levels disconnects the pattern language since the patterns on different levels are then too far apart to be related.

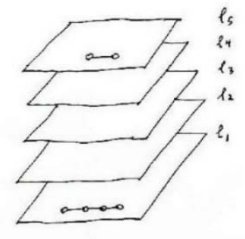


Fig. 19. Two groups of patterns are too far apart in scale to connect effectively. (Salingaros, The Structure of Pattern Languages, 2000)

One of the principal methods of validating a pattern language is that every pattern is connected vertically to patterns on both higher and lower levels. Damage to a pattern language can be understood visually, by crossing out any single pattern.

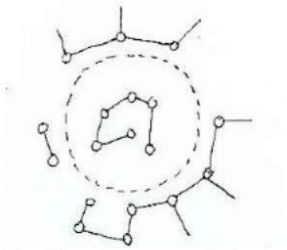


Fig. 20. The enclosed pattern candidates are internally consistent but fundamentally flawed because they fail to connect to external patterns. Losing them damages irreparably the way a society functions, because architectural patterns help to define all the higher-level social patterns (Salingaros, The Structure of Pattern Languages, 2000).

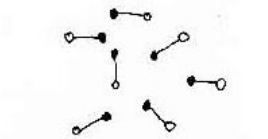
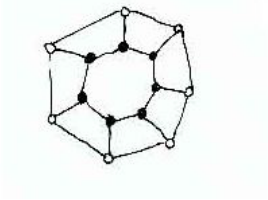


Fig. 21. Architectural patterns that pair with social patterns (solid) further combine to create a socio-architectural pattern on a higher level (Salingaros, The Structure of Pattern Languages, 2000).

Sometimes, a pattern might have an unwanted secondary characteristic; the same way an inherited trait in an organism may be essential for survival but have a mildly negative side-effect. The same pattern is expressed as two different features.



Based on the analysis from Salingaros using the label over the patterns allows to connect them in different layers, over the design. Considering that the attributes in the design have spatial relationship and can be connected through adjacency and values, could condition the result of their significance.

1.4.1. Mathematical graph theory

If there is a thought about the field of architecture, is notable that it has related to mathematics on all its processes, connected to raise the structures and the objects proportions and other calculus needed to design an object. That relationship has been set and its maintained nowadays (Salingaros, Architecture, Patterns and Mathematics, 1999), for that reason, to continue with this research it will use the mathematical insight with the purpose to obtain the quantitative order from the patterns.

Based on the Salingaros and Hillier documents the graph mathematical theory is demonstrated as one of the best methods to make this type of analysis because it is a combination of rules working in the visual frame of logic, giving graphical terms, input the scope, and this is the basis for the graphical drawing and presentation of them.

Based on some books, the definitions of a graph are formed by vertices and edges, connecting them creating a relationship between them (Ruohonen, 2013). A graph is a pair of containing information labeled.

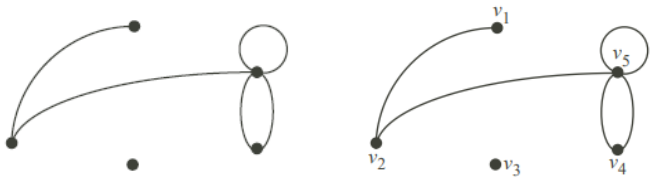


Fig. 22. Graph connection vectors (Ruohonen, 2013)

With this general information is understood that the connection of each vertex, in a labeled way brings the facility to compute complex pattern recognition and image analysis. This is a framework for interpretation and the most important key element; a graph works in hierarchy and it's easy to connect as it is segmented, with this method it recognizes, manipulates, and it allows to create the relation of each element (Jean-Michel Jolion, 1998).

One good example from graph that can be used in this research is from the Heuristic Search Strategies, in 1972, Martelli showed that the problem of boundary detection can be cast to the problem of finding the minimal cost path in a weighted and directed graph, with positive costs, but this definition is clearly understood through this chart (Jean-Michel Jolion, 1998).

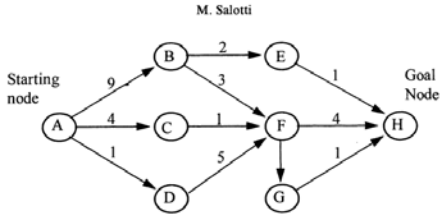


Fig. 23. Graph example. ADFGH is the best path to the goal node. (Jean-Michel Jolion, 1998)

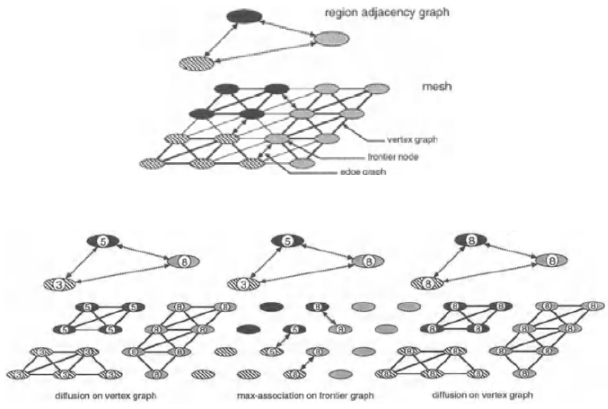


Fig. 24. Region adjacency graph. Graph connectivity depends on the level of adjacency and interconnection. (Jean-Michel Jolion, 1998)

With this example is understood how the configuration of the patterns in the hierarchy can follow the path to measure the patterns on the objects stablishing the connectivity. In this stage it is analyzed how this information can be extracted from the case study from Hillier, the figure above demonstrates how using the mathematical graph, is possible to summarize the information from the layout disposition, that is only one step for this analysis but allows to measure the connectivity and relation in the space.

In this research the studies are on visual information in the planar dimension, for that reason the parametrization allows to read the message from the design in its understanding. But this realization is between the organization and its information. And this study focused on the design, it is pretending to cross the layers of connectivity using the geometry from its connection from the aesthetics, the space, and the shape (Allen Klinger, 2000).

1.4.2. Fractal theory

Based on the terminology fractals referred to broken (Salingaros, Fractal Art and Architecture reduce physiological stress, 2012), but the characteristics from the fractals tend to explain the complexity of its nature presented by Mandelbrot where the shape of nature elements were not as it was appreciated before (Mandelbrot, 1977) demonstrating that fractals are complicated and irregular (Bin Jiang, 2014), and this irregularity is appreciated through some patterns in a dynamical behavior going from the infinitely interactions, to end in a complex process of repetition, from the simple one in the beginning until the more compound one (Crownover, 1995).

Fractals are part of the surroundings from the nature and into the society, shaping cities, streets and other elements that define the complexity behind the math and geometry that fractals infer (Bin Jiang, 2014). Nevertheless, fractals hold a characteristic that is the self-similarity through the scale of their elements (Crownover, 1995) meaning that the infinite loop from the pattern repetition end in the same or complex shape through the cycle. This characteristic of homogeneity from the fractals comes from the topological property, understanding this term as the metric space without metric (Miles Reid, 2005), this is observed in the forms that fractal generates.

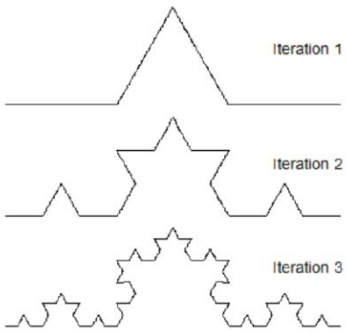


Fig. 25. Koch curve (Bin Jiang, 2014)

In the figure 25 it was observed the Koch curve as a fractal curve where the iteration is a subdivision from the original shape in a sequence of 8/5 times the area from the original triangle, the Korch curve is an example from the finite and infinite possibilities behind fractal's geometry and math, however fractals tend to show pattern from façade and nowadays thanks to the computational advance, complex façade shape could interact with fractals solutions and the connection with the research that the pattern could be described in terms of fractality in self-similarity.

Fig. 26. Fractal applications on façade (Amal Osama, Fractal geometry in architecture: from formative idea to superficial skin design, 2014)

In terms of application fractals provide the opportunity to evaluate objects in a nature form of interrelations already presented in the CAD paradigm, at the same time the nature from fractal opens the possibility to connect the nature form of any building façade through fractal dimensions.

1.4.3. Facade's analysis case studies

As mentioned before, façade in this part become a relevant aspect, a façade is defined by different concepts, one of them is the visible part of a wall that is capable to transmit or reflect the building's unity, promoting the readability of its tectonic elements is the analysis of multiples façades, where façade is the element, from a partial part or whole, but with the characteristics to reflect its own identification (Alban Janson, 2014).

Considering that the façade is an important part of the communication, previous studies on facades reflect the interest to understand these characteristics; for example, the composition analysis from axial lines from different facades represent a pattern (Lara, 2006).

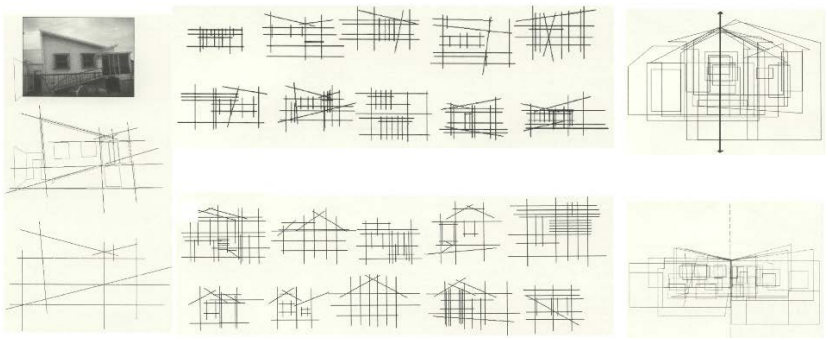


Fig. 27. Façade analysis through axial lines, comparison, and interpretation and juxtaposition of lines. (Lara, 2006)

In figure 27, the method of analysis was under the identification of main lines that the façade represents into the exterior in an specific area of some neighborhood in Brazil to compare the changes between the modern design and the actual ones, the lines that show the element were drawn through a CAD software, the objective was the identification of composition features and patterns from the façade, where each element represents an important role; subsequently, the lines from each façade were overlapped to observe the main pattern or distribution. In this example, the analysis reveal that the drawing of lines is a direction to further analysis.

As seen in it with the previous example many investigations used the façade for different type of analysis, in this case, the example is considered as an analysis that Hillier made for the buildings to observe the best path for this research's façade studies.

i. San Sebastian and Barcelona Pavilion space syntax analysis

In this chapter is analyzed the advancement from the architectural theory to the mathematical insight from Hillier and Salingaros. These two authors along their careers have been developing ideas that represent the value of architecture through and objective side. In this case, Hillier uses the graph theory and the tool developed by UCLA - space syntax tool, as a part of his investigation, he realized that the studies from the beginning that where set to the urban field could have the same importance through vertical elements, and in this case the façade itself (Hillier, Space is the machine, 1999).

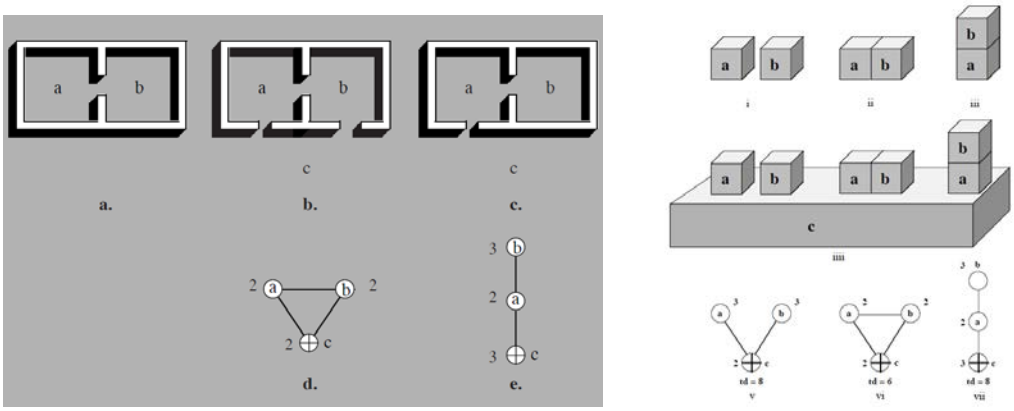


Fig. 28. The j-graph and spatial relationship. (Hillier, Space is the machine, 1999).

In figure 28 Hillier showed the relation from the space between a and b, each connection follows the logic of connectivity where the hierarchy of connection is comprehended from the functional position in a. It is observed that a and b are directly connected without any exterior influence but in b, c is interconnected with a and b, and a and b are interconnected between each other; but in c, is a linear path where b is interconnected by a, a with c; but c only with a is described in e; and the b in the d graph. From the right side, is the same analysis of connectivity but the difference is that in the second line the differences start when is added the line of emplacement and the adjacency of the element, the i refers that a and b are interconnected with c, but a and b are not with each other. In ii, a and b are interconnected or joined in the space and at the same interconnected with c. At iii, it shows the linear hierarchy of the elements starting from c, going to a and ending in b, presenting a linear graph connection in an order of element.

This research goes in the direction of visual information from the façades as configurations, decoding the information from each element or attribute that the building could bring, if analyzed the figure 29 it shows the way how to find the connections from each attribute in the composition side, like Hillier made with the symmetry in the buildings.

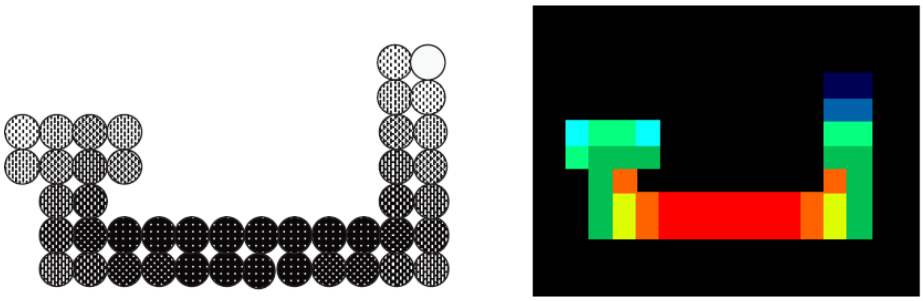


Fig. 29. Asymmetry J-graph analysis. (Hillier, Space is the machine, 1999)

With this example using the j-graph isomorphism, is possible to appreciate the asymmetry. This analysis is based on the depth values from each square divided by the quantity of nodes, and this is interpretated as the symmetry index from a façade of a building (Hillier, Is Architectural Form Meaningless?, 2011); however, Salingaros demonstrates a further analysis from the side shapes and forms.

The configuration from the building shape is represented by colors gradients, this method guides to perceive the propositions about architectural forms demonstrating the possibility to appreciate properties from them.

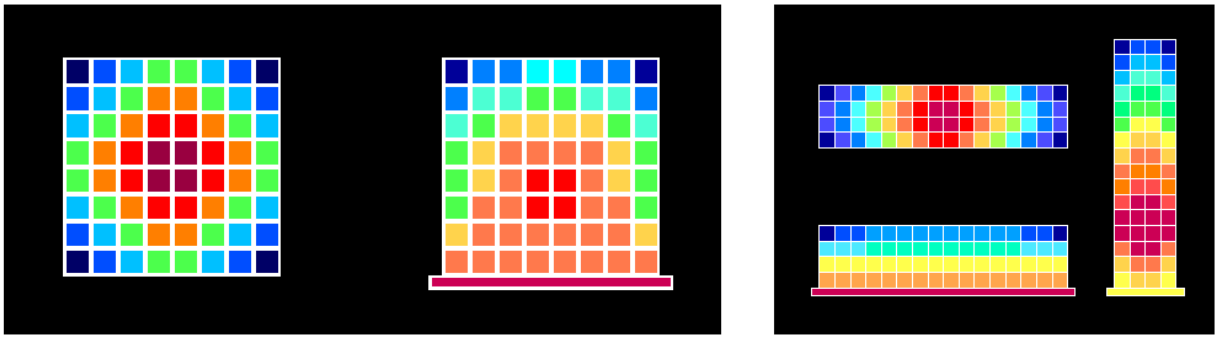


Fig. 30. On the left the analysis of an 8x8 square shape. On the right the analysis with the earth--line added. (Hillier, Space is the machine, 1999)

This example in figure 30 are the San Sebastian Design by Alberti to the left and the Mies Van de Rohe’s Barcelona Pavilion to the right. Like it was mentioned before colors represent the value of connectivity from each node, the blue represents higher value and red as low value; in this part the most important conclusion that he presented is the correspondence of shape alignment along the surface, more equal they become more symmetry represents itself. For this research is not about the discovery of relationship between the symmetry index but taking the input to explore other approximations to maximize it in more attributes that the objects could provide.

On the other hand, these features of symmetry through this analysis are an opportunity to explore the possibilities to apply proportion in the objects, considering that this attribute from the object is possible to communicate, that exploration will be possible in the next phase of the research (Salingaros, Architecture, Patterns and Mathematics, 1999).

ii. Spatial configuration in facades by image sampling

In this case study the report was conducted to analyze the physical shapes in the buildings using image sampling through pixels information from pictures of dwelling houses' facade.

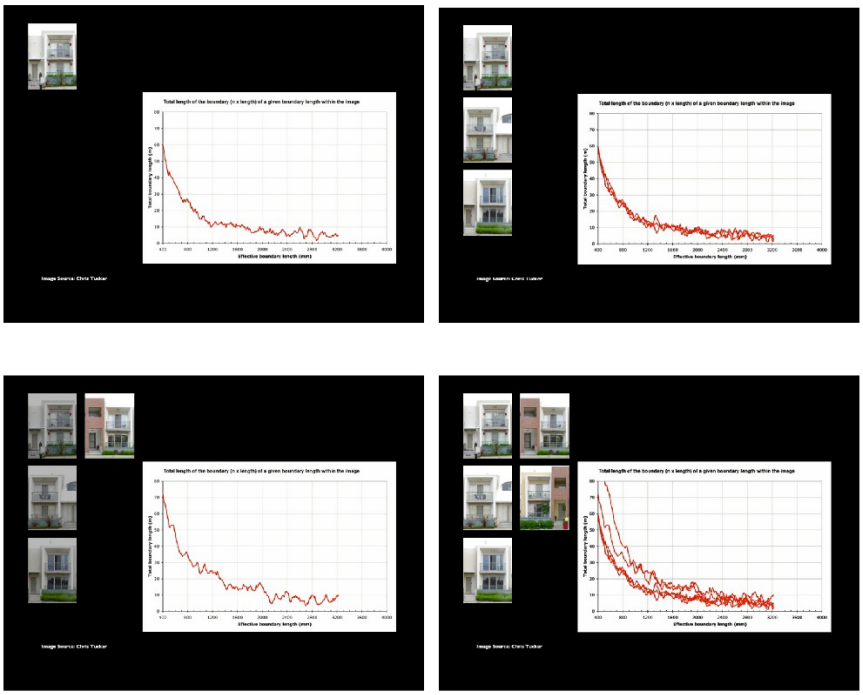


Fig. 31. Image sampling graphic from facades samples. (Chris Tucker, 2005)

The diagrams of figure 31 independently of the analysis through the façade using pixel information and distance between them as main data to generate the graphic, this presents the different changes that the façade had through their shape and form, demonstrating that the uses of analysis through image sampling could provide a perspective to explore other elements (Chris Tucker, 2005).

Overall, from this report an important and relevant data from this example is the factor of scale that a building façade could have because the scale over the measurement of line analysis might have a relevant result, the comparison between the data to reveal the changes and relationships, and how the homogeneity could correspond to some patterns, regardless to their elements and interconnections with their styles as the report present through colors, shadows, and object recognition with the test samples.

iii. Façade attributes determination based on façade reconstruction parameters

This case study goes over the analysis of mathematical model to predict façade reconstruction and at the same time propose the use of façade structure grammar as a perspective to introduce an order over the elements that a façade from a picture could represent. The research establishes the necessity to understand the knowledge of computer aided programs to find a structured information from the objects.

The sample over 400 façades is a higher concentration of data, that in this research for relation of time is over samples to generate the basis for the implementation.

The grammar rule that this article present started by the symmetry of the building, approach that was previously mentioned and analysed by Hillier and Salingaros; however, the grammar rule presented represents the elements from the windows and façade over all their characteristics of position and dimensions.

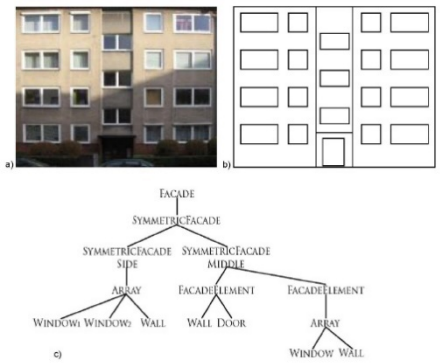


Fig. 32. Grammar rule hierarchy model by (Ripperda, 2008)

Grammar rules demonstrate that the order set the priorities. In this case study the facades were represented using the CAD software of ArcMap in a flat and perpendicular picture, image sampling become manual by creating areas over the images.

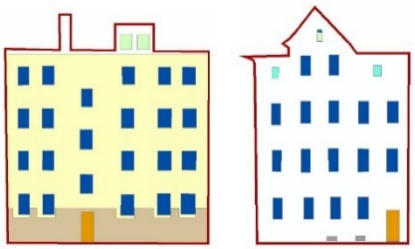


Fig. 33. Manually façade drawing ArcMap by (Ripperda, 2008)

The facades are measured following rules to determine the comparison with the samples, considering the ratio, proportion and disposition to posterior use the RJMCMC mathematical prediction to do the windows reconstruction. Remarkable element from this case study is the approach to stablish rules to create the future elements, based on the samples collection.

Summarizing, the different cases studies presented before had pros and cons evaluated through the next table:

Table 5. Case studies comparison methods by author

	Advantages	Disadvantages	Comments
Case study 1 (Convex Map)	Analysis is aligned with the research. Method is clear. Symmetry become a starting point.	Convex is strictly based on the shape and demonstrate a unique index overall. Analysis runs in a frontal elevation.	Exploration should procced to use the other syntactic tool such as axial and segment analysis through other façade examples.
Case study 2 (Image Sampling)	Image sampling used accurate information. Scaling is a factor demonstrated in the case to measure differences from the elements.	Orthogonal views from façade elevation tend to be difficult to take considering perspective corrections.	Distance from scaling windows and doors could be implemented in the façade elements.
Case study 3 (Façade reconstruction)	Façade grammar is mentioned. Projections allow a precise. representation from the grammar rule. Used of a different CAD tool provide a wider approach for implementation	The projection is based on the data collected ended in windows and doors. Shape of the buildings creates a constraint due to the boundary	Projection is a factor to be evaluated over the parametrization considering that the parametrization will be based on rules

From the previous table space syntax method is the most accurate for the investigation considering the relationship of physical objects and social cultural relations implied over the application, in the case to found the patterns the space syntax procedure allows the construction of discourse provided by Hillier (Hillier, Space is the machine, 1999) in the calculation of spatial inter-relationships in the physical environment although the opportunity to combine spatial analysis through the applied mathematical and cognitive information (Claudia Yamu, 2021).

1.5. Conclusions and theoretical model of pattern parametrization on buildings' façade

1. In order to be close to find an answer for this research hypothesis, from the previous investigations and the literature review, can be concluded that the possibilities of this study are connected to do the emulation from the object patterns presented by C.Alexander, in a hierarchy tree, conducting the identification of attributes or characteristics from the patterns; for example, as the previous mentioned symmetry, since in the previous cases studies is the most clear to understand from the mathematical and grammar point of view at the same time demonstrate that is possible and feasible to find a path to make a further analysis between the interconnections that the objects could have including other composition features; nevertheless, is needed to be aware that not all the attributes in the space allocated in the objects can be translated because some patterns attributes could lack in intelligibility in one of them or others, forcing the challenge to consider the split layers in the object.

2. Following the previous statement, part of the analysis is to set a clear hierarchy of attributes, giving the example that symmetry is the first attribute to be identified, it would be an important asset to determine what it would be the second attribute, from the observation of the objects, in view of the possible order of analysis and interpretation; based on that statement, the order allows to set a value of priority if applies for the case; considering symmetry as the first one, should have a different weight to measure the value quantity. This part is addressed by some surveys related to layer order from the objects patterns attributes, giving a first asset to evaluate how the users or the designers prioritize the reinterpretation of many attributes.

3. Considering that nowadays the architectural production related to all the designs, the selection of samples, should be a prior statement in the future considering that this type of analysis should run in objects that present clear composition characteristics. if thought in the richness of the object in quality, this sample should not differ in typology considering the scope of a house will not the same like a skyscraper, but that does not mean that the sample selection could not have a variation of styles, in correspondence styles should not be a problem in the sample selection because each style runs in the same principle of "applied theory" and in consequence, in attributes; but, far from that point some typologies ensure a better analysis; as a result, this selection is discussed and revised with the prior to ensure future results.

4. The analysis of this research runs in a 2-dimensional conception through the façades in order to facilitate the exploration in a planar point of view, but that does not mean that the consideration of the 4 facades of the building gives some valuable information that later on should be measured, considering that each element from the object represents a valuable information, and it composes the universe from it; for that reason, in this stage the focus is on the main facade.

5. After the review of different case studies like the façade deep value, façade pattern analysis, and façade reconstruction, the analysis proposal is decided using the graph theory from the current framework of analysis, in them, symmetry is a key element, using CAD tools like space syntax, image sampling and fractal analysis (if applies), providing a set of rules for each case, considering that each method will generate some ponderation of data that should be integrated with their interpretation, in consequence, the aim to generate an universal language could apply to different stages of reliability on the objects, creating a "particular" method for this research and in addition the capacity to reproduce considerable elements on the design as mentioned before that mostly are understood in the subjective approach, revealing and ensuring a level of objectivity that each object or design could have based on the parametrization of elements.

6. In this research, objectivity should lead to the aim of representing the real attributes that the objects could have, and the setting off values should come from the users and designer's trough surveys and questionnaires, considering that value setting should not become in bios, should become from the interpretation; with that information, it is considered a value evaluation, even though that it can use binary expression to set the values for the analysis, and represent the results between them. From one side is to get information that run-in appreciation, and the other one based on correspondence of factors, if decided that it has symmetry, it can be set the prior to 1 and if does not have then it can be set the prior to 0. If measuring the capability of symmetry from the object and at the same asymmetry could be the result, creating a hierarchy of results, working in the different layers mentioned before, but mostly as a prior will go on vertical and horizontal direction, creating a logic statement of evaluation and additional possibility to explore in detail.

To set a guidance along the research it was designed this theoretical model map:

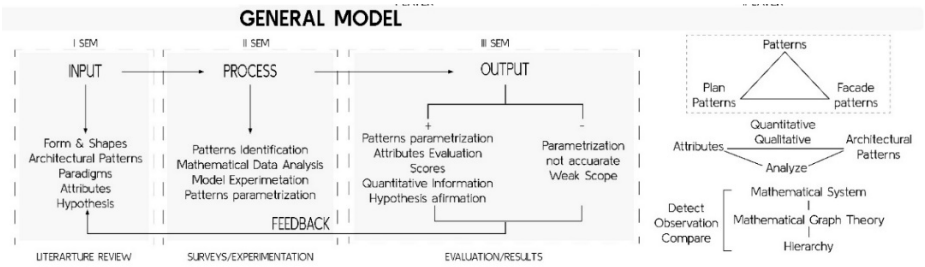


Fig. 34. Theoretical model by author

2. Empirical research applied to the architectural patterns on buildings' façade

This chapter is focused in four main parts the first part is related with the development of five hypothesis statements with the objective to provide a guidance between different methods and technique to found the production to stablish a parametrization method of rules and the pattern interpretation previously mentioned, the second part is related with the inquires through a sociological survey , the third part is related with the evaluation of space syntax through CAD drawings models and the last part is the comparison between the survey and foundings from the space syntax tool.

Based on the definition a hypothesis is the demonstration of measurements (Ruane, 2005), that predicts a relationship between two or more variables, this type of variables should be scaled and testing for that reason 5 hypotheses are presented to find an experimentation guidance to observe different results through the main topic, looking for a higher correlation between variables, as the deduction methods infers (John Adams, 2014) to prove the hypothesis.

Despite the fact, the research will end in an experimental design in the third phase, the literature suggests that in this type the most important factor is the randomization of sampling (John Adams, 2014). For that reason, the collection of data will be between qualitative and quantitative aspects. The methods of data collection for empirical research are questionnaire, focus group, interviews, case study. From the list below, case study was analyzed in the previous chapter, however in this empirical research, will be conducted a survey through a questionnaire, considering the sampling method and time as a factor considerable in the survey development, the survey will be in small-scale based in sample population.

For the collection of data two methods are commonly used the probability sampling and the non-probability sampling. Probability sampling refers where each element of the sample had the equal chance of being selected and the non-probability is the chance of being selected is unknown. In this research it was not count with a formal list, in consequence non-probability sampling is implemented, this one is applied through five main types:

- Convenience sampling: as the expression the sample tend to be "convenient" to the researcher.

- Purposive sampling: is considered a judgment sample where the researcher tried to set criteria to ensure the data collection.

- Quota sampling: this one is similar to the purposive but the difference that this one could be performed by an individual researcher and tried to replicate proportions of demographic factors.

- Snowball sampling: is considered when the respondents suggest to other ones creating a network of participants, for this case it was implemented.

- Self-selection sampling: is considered when a self-selected sample is simply one which the respondent put themselves forward to participate in a survey.

In continuity with the testing part from the research, the experimental part will be the reply study from Bill Hillier's study in facades, as mentioned before the procedure is based on the space syntax software "DeptMath" this software was develop originally by Alasdair Turner and is an open source and multi-platform spatial analysis software for spatial networks of different scales. (London, 2021).

This tool is set in many scales, buildings, urban areas, cities, or states. The result of the implementation is a map of spatial elements and connectivity via relationship such as intervisibility, intersection and adjacency performing a graph analysis of the resulting network, at the same time the software provides variables which should have social or experiential significance through topological features.

The last stage for the empirical research is the comparison between the results from the survey and the data from the space syntax tool, comparison analysis is identified in 4 types (Pickvance, 2001):

- Individualizing comparison is the contrast between a small number of cases with the objective to found peculiarities of each case.
- Universalizing comparison is the founding of the same rule over each instance based on phenomenon relationship.
- Variation-finding comparison is the particularity to set the principle of difference in the scale of character and intensity analyzing the differences between the instances.
- Encompassing comparison is the preset of different instances in the same system, in order to observe his behavior as a function and their variations in the relationship into the system.

From the mentioned below the analysis will go to do individualizing comparison, universalizing and variation-finding in each case to demonstrate their relationship and particularities.

2.1. Hypothesis definitions from parametrization of architectural patterns

Considering the theory oriented in buildings' façade analysis in the previous chapter and the unknown aesthetics interpretation influence over the different paradigms, the premise of hypothesis will be the guide to confirm or reject this thesis, to complement the first theoretical model presented before the hypotheses are presented:

1. If the object as "a whole" can be evaluated and synthetized from its compositional features, throw the mathematical approach will allow us to measure the abstract nature quality of the building.

With this it should consider that buildings had the possibility to be classified in strata , providing a defragmentation of their elements, for example the same building or in this case the facade as a whole contain composition features such as: symmetry, hierarchy, rhythm, proportion and other ones, in order to obtain a relevant information façade visual analysis is used, using the CAD technology to visualize these features and assign to each of them a value to scale or measure their correspondence.

2. If the facade analysis is split in layers, would it be possible to recognize composition patterns from the façade?

This hypothesis is another way to describe the façade in terms of information from the façade composition features, stablishing a primary order between them, guiding the set of order of recognition, and exploring the possibility to appreciate the elements inside the lawyer that an element could represent. This hypothesis refers that through the analysis it should be evaluated the relevance of layers from the first perception of building information.

In this hypothesis it is used empirical observation from some buildings samples to generate examples to compare with other ones and it will be supported by the sociological survey from sample selection.

3. What is the hierarchy of discoverable composition patterns recognition in a facade from the buildings?

Building's facade contains information, and it leads to create the hierarchy starting by the unity of the element through their composition syntax hierarchy. This hypothesis will use empirical observation from some samples, sociological survey from a selected amount of people.

4. Attributes from the composition pattern recognition can be taken as a summary of each facade from the buildings or should they be taken individually?

This hypothesis refers in the sense if the attributes from the composition elements could be counted, distinguish by the layers and them split in inner layers, this separation represent the summarization as a hole or for each subsequent layer should be counted in a different pattern or score, as explained before, and as consequence all the summarization is a result from all the elements compounds.

5. If the composition attributes had the possibility to be described through mathematical analysis and being compared with the people perception from samples in order to understand the inner language from the architectural pattern?

This hypothesis leads the idea if the façade present in this path of pattern reinterpretation a solid number of information interconnection with an easy way to correlate with the user's identification this set could be generate grade of scoring based on the result of the surveys and the data extracted implementing syntactic tools.

Thereby, in all the 5-hypothesis analysis it uses empirical observation from some samples that should relate to the main paradigms and companied with sociological survey from sample of people that are designers due to their possibility to recognize visual composition elements.

i. Composition syntax structure in architectural objects

In this part is considered how the analogy of syntaxis (Carnie, 2007), will give the path to understand how can the façade be set of one object in many parts, if considered that the cannon of beaty (Vallentine, 2002) is the inner perception of interpretation that came from the result of the addition (Hillier, Is Architectural Form Meaningless?, 2011) of all the elements that one object could have, what it would be the order and the transition of this elements, for that reason, this addition of theory over the buildings, express that first the object is the result of all the information, that in somehow goes in hierarchy until the minimum expression that could be appreciated in their visual frame (Seyed Farhad Tayyebi, 2019).

The object will be identified as a unity, then subsequently the layer will be divided in the main elements that contains the rest of composition element, and then the next elements would be divided in subgroups that are compounds from the original, going in a tree branch of elements, in this stage is important to denote that these elements should be differentiated, because windows present a pattern that can show rhythm or other pattern (Sotirios D Kotsopoulos, 2014), make the remark between an element that compounds the object itself between other is important to set the frames of layer for future analysis in this investigation.

For that reason, this conceptual graphic is presented:

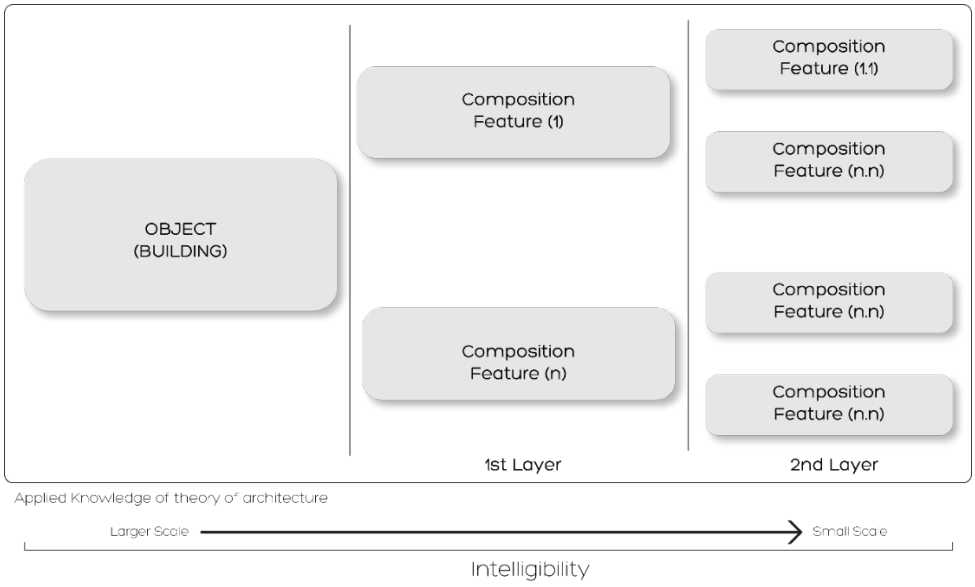


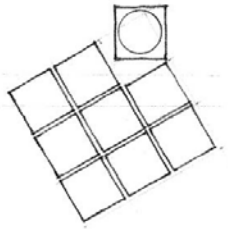
Fig. 35. Composition syntax intelligibility by author

ii. Architectural composition patterns

In this part is mentioned some of the compositional element that will be analyzed through the research, considering that the design itself use a lot of elements on the production of an object, it was chosen those ones that could be easy interpretated by users and people in general knowing the scope of the composition has been understood it until today. (Pelt, 1902).

– Hierarchy

Is the element that could be arranged in an order to catch the attention, it could a shape or element that is the joining of other element in the object, this is not a focal point and it should be seen as an element that had a remarkable feature in the building.



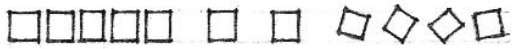
As F. Ching mentioned it could be a shape, or placement relative to the other forms and spaces of the organization (Ching, 2007).

This terminology applies that in the realm of the visual façade this arrangement of features proves that the recognition of an important feature.

Fig. 36. Hierarchy diagram (Ching, 2007)

– Rhythm

Is almost present in different buildings but in this case, it is summarized in the repetition of elements in the buildings, this could be a volume, line or an element that shows a pattern of element synchrony.

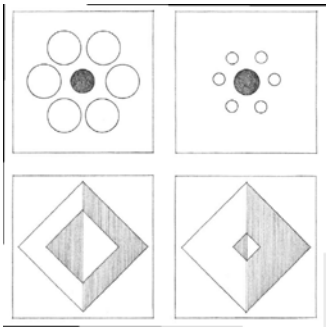


This figure represent that this feature consists in the patterned repetition or alternation of formal elements or motifs in the same or a modified form.

Fig. 37. Rhtymn diagram (Ching, 2007)

– Proportion

The relationship of measurements from the object itself that can go from the unified object to each element on harmony to enhance the quality of it.



Considering that the physical dimensions of architecture, of proportion and scale are imprecise. Denotate that the quality from this feature could correspond to different elements such as material properties base on dimension and the quality of them and the capacity of arrangement, in this case the situation of analysis will be in the mass of the object as a united element, due to that each element on the object correspond in proportion with the main object, following the layer structure of composition syntax.

Denotate that the quality from this feature could correspond to different elements such as material properties base on dimension and the quality of them and the capacity of arrangement, in this case the situation of analysis will be in the mass of the object as an united element, due to that each element on the object correspond in proportion with the main object, following the layer structure of composition syntax.

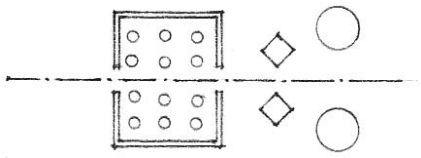
Fig. 38. Contrast diagram (Ching, 2007)

Contrast

Usually comes with the clarification of negative and positive features, if having a depression surface should be other that emulate the opposite effects.

– Symmetry

Symmetry as understood, is the equilibrium of parts from the unified object, in this research this architectural element become the first analysis documented in the cases studied.



Based on the diagram where the symmetry is related by center or axis.

Fig. 39. Symmetry diagram (Ching, 2007)

2.2. Analysis of model samples based on the paradigms of classicism, modernism, and CAD

Following the prior order of the 3 main paradigms (Grabow, 1983) the study should take in consideration the aesthetics influence from representative buildings and how the composition arrangement were settle on them, since the study will conduct a deeper understanding of how the perception of appeal can be linked with clear identification, it was analyzed the major documentation from these relevant buildings to each period inside to their paradigms, hence the selection contained two religious building, two houses, one apartment building, three museums and one research facility center.

The selection of samples for analysis came with the statement of richness, the quality and the important that they represent in each period from the paradigm where they belong, and the 3D data free resources to do analysis of distance from the object through the 3d software setting the observer from a distant where the building is appreciated under some distance scale and additionally the quality from the composition elements that they had indistinct from the building period.

Table 6. Paradigms building selection by author

Paradigm	Name	Typology	Composition features										Total	
			H		R		P		C		S			
			S	C	S	C	S	C	S	C	S	C	S	C
Classicism	The Phanteon	Temple	1	0	0	1	1	0	1	0	1	0	4	1
	The San Pietro Temple	Church	0	1	0	1	1	0	1	0	1	0	3	2
	The Royalt Salt Fabric	House	0	1	0	1	1	0	0	1	1	0	2	3
Modernism	The Unité d'habitation	Apartment building	0	1	0	1	1	0	0	1	0	1	1	4
	The Farnsworth House	House	1	0	0	1	1	0	1	0	1	0	4	1
	The Gugenheim Museum	Museum	0	1	1	0	1	0	1	0	0	1	3	2
Parametric	Heydar Aliyev Center	Museum	1	0	1	0	0	1	1	0	0	1	3	2
	South Australian Health and Medical Research Institute	Research facilities	1	0	0	1	0	1	1	0	1	0	3	2
	National Museum of Qatar	Museum	0	1	0	1	0	1	0	1	0	1	0	5

Composition features (S: Simple or C: Complex). H: Hierarchy, R: Rhythm, P: Proportion, C: Contrast, S: Symmetry.

From the table No. 6 it is appreciated that the 9 samples hold all the composition elements for the study, the procedure to identify the complexity or simplicity for each element is based on the criterion about how the element in the building is easy to identify and the complexity of the shape. For example, columns in the Royalt Salt Fabric are constant repeated in the façade but at the same time this holds repetition of cubes into the columns generating a complex rhythm in the façade rather than the pantheon that the column as an element is repeated without any other addition into it (not considering their structure of base, Fuste and Capitel). Concluding in the next classification: Pantheon (S), San Pietro (S), Royalt Salt Fabric (C), Unite of habitation (C), Farnsworth house (S), Heyder Aliyev (S), South Australian Health Research Inst (S) and the National Museum of Qatar (C). this previous analysis based on the observation will be confirmed through the survey to compare between them the results.

2.2.1. Façade building selection based on classicism paradigm samples

For this part, it was wchoose three main object samples to analyze, but with the conception related to not to select buildings through a longer period due to the understanding of aesthetics could have a relevant influence, for that reason it was selected:

– The Pantheon (113–125 AD)

Knowing that the case study presented in the previous study was in a building similar to the Greek temple, it was considered to take this sample from an ancient Rome building that present a similarity not in style but in elements that are identified like Hillier made before.

This building presents a configuration of a portico by a set of columns and a tympanum in the top of the columns, and in the background, it can be perceived the cells. This analysis will focus on the façade giving the presence of 4 elements for the study that are a visible hierarchy from the tympanum, rhythm through the columns and in correspondence contrast between these elements and the open space between them, proportion is already implicit knowing that this building was built it following golden ratio proportion.

Fig. 40. Image of the Pantheon (www.askostours.com, 2019)

– The San Pietro Temple (1500 BC)

This building is a harmonious renaissance building that present a difference related with the layout organization creating a different perception due to the round disposal at the same time denotate the presence of more columns in the round layout. In this example the proportion is following the golden ratio aspect and the prevalence of hierarchy and contrast is not easy to denotate between all the elements because ornamentation plays an important role along the façade transforming in an object that is not simple to segregate in parts, but this parts clearly shows rhythm in conjunction with the object.

Fig. 41. Templetto de San Pietro (www.khanacademy.org, 2019)

– The Royalt Salt Fabric (1775 BC)

This building from Nicolas Ledoux is a demonstration from neo classism architecture that present the same pattern from The Pantheon, a portico with six columns in the front and the tympanum on the top, and the cells present a pyramid roof whit a square area. In the analysis it is observed a clear difference in the aesthetics point of view, in the columns the addition of theory creating a rhythm over the columns, refers the analysis of layers from their elements. This building is clearly symmetric, with a presence of golden ratio proportion and the contrast that convey in solids, voids and shapes in their different elements.

Fig. 42. Royal Saltworks at Arc-et-Senans (travelguide.michelin, 2019)

2.2.2. Facade building selection based on modernism paradigm samples

The second paradigm with the study goes from the direction of how the elimination of aesthetics, elements cover significance in the visual interpretation. The selection of samples took in consideration 1 house, 1 apartment building and 1 museum, the selection is according to the paradigm and not a proper style approach.

– The Unité d'habitation (1940)

This building was designed by Charles Jeanneret in the II post war period, in that period the objective was the reconstruction of many cities, as a result this building is an iconic object from that period, being an icon of its time for its functionality. The building was set using the Modulor proportion and the establishment of elements denotate a different progressive rhythm along the façade, hierarchy is visually conducted by its massive core stairs and the contrast visually made by materials is not denotate by a volume frame like in the classicism where the elements create this type of contrast feature.

Fig. 43. The Unit of Habitation (BBC, www.bbc.com, n.d.)

– The Farnsworth house (1949-1951)

The Farnsworth house designed through the international style by architect Ludwig Mies van der Rohe is a building with a visual permeability with the implementation of materials that change the visual perception of a house, in this case the presence of ornamentation is clearly absence but in correspondence with the volumetric proposal that combines the use of golden proportion, and a formal hierarchy along the horizontal line, the building is a unified object with clear lines, but in the distance rhythm is not easy to distinguish, because is not following a volumetric correspondence in fact just lines and elements that support the main volume, is important to mention that this building was analyzed by Hillier already presented in the case study.

Fig. 44. The Farnsworth House (Archdaily, 2019)

– The Gugenheim Museum (1959)

This building designed by Frank Lloyd Wright as an art museum clearly represent a maturity of the representation of element avoiding the strong presence of vertical and horizontal shapes, giving the opportunity for a circular shape that redefine the visual façade frame. In particular this object had a different approach from the other samples, considering that the building clearly represents a progressive rhythm at the right side and other volumes trough the horizon. The contrast is obtained between the spaces through all the elements, proportion recover its importance due to in this modernisms movement golden ratio prevail in mostly all the design elements and at the end the hierarchy from this building come from the reshape of the fronton along the façade.

Fig. 45. The Gugenheim Museum. (Pielage, n.d.)

2.2.3. Façade building selection based on based on CAD paradigm samples

The revolution of using CAD in different stages nevertheless the phases, changed the way of how the production of architecture is already performed, for that reason this sample selection was focused on objects that are properly designed using parametric features.

– Heydar Aliyev Center (2012)

The building was designed by Zaha Hadid Firm is a clear representation of the use of curve and smooth lines through the object, where composition features elements, are inner or hidden in some elements, but restricted from the point of view, in the façade it was presented a hierarchy statement due to the volumetry of some elements, the proportion does not follow the golden ratio but follows the element proportion between deepness of their elements and the rhythm as a volumetric feature is presented in the right part of the façade and at the end contrast is created by the essence of material.

Fig. 46. Heydar Aliyev Center. (Crow, 2019)

– South Australian Health and Medical Research Institute (2013)

The building emulates a parametric skin covering the entire object. It was designed by Woods Bagot Firm and the façade presents a pattern of repetition of small element that is translated as a rhythm, meanwhile the proportion of their elements relies in each of them due to the façade is a defragmentation from the façade pattern, the contrast is between the material finishing over this pattern and the hierarchy from this building respond to the abstract of horizontality more than another specific feature.

Fig. 47. South Australian Health and Medical Research Institute (Clarke, 2014)

– National Museum of Qatar (2019)

Designed by Jean Nouvel this sample is a complex building with a presence of plane interconnections mixed through the object, making difficult the capacity to identify by simple observation more than three composition element in its façade. Rhythm is the result of the element through different angles and position, the contrast is made by the voids conjunction generated by the plates along the object, hierarchy is not easy to recognize due to the organization of the elements and proportion convey in a relationship of distance.

Fig. 48. National Museum of Qatar (Kus, 2014)

2.3. Compositional elements on façade from model samples through sociological surveys

For the establishment of the sociological survey considering the sample selection was under nonprobability sampling from people who had some general knowledge in design, through the snowball method to replied and collect the data over and heterogeneity sample. The survey was prepared under 4 sections the first section corresponds to the generalized data, the second section was based on option selection, the third section was based too under option selection and the last section is based on Likert scale.

In the first section the data collected provide the confirmation from the samples in the sense to know the audience and their background to identify composition features, the second section is distributed in three subsections where one frame contains the picture of three façades from each paradigm; the objective is the audience selection from the most appealing building to them, the organization inside the frame is randomized over the section.

The third section was made based on four composition elements identification in the nine buildings, the aim is to recognize from the pictures the most striking composition element, in this section there is not a sign to let the audience to have some influence in their decisions so the answer should reflect an impartial selection. The fourth section is also based on the nine buildings presented under liker scale to know the score from the element that they like most and they identified, the score evaluation will help to measure the correspondence between the element that they identified in the third section and the value that this represents to them.

– First section: generalization data

The sample participation was under 107 participants, represented in the figure no. 47.

Fig. 49. Survey location answer by author

– Second section: paradigm preference

This section provides the preference of paradigms due to the aesthetics is something that belongs to the period, and the answer will give the alignment from them, which are is most acceptable, if it is understood that the applied knowledge under the architecture provide a different comprehension under the aesthetics.

Fig. 50. First block paradigm pictures by author

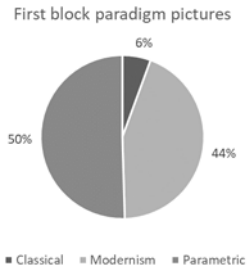


Fig. 51. First block answer graphic by author

From the picture 49, in the first block frame the audience select as the most appealing the parametric building followed by the modernism and the last the classical.

Fig. 52. Second block paradigm pictures by author

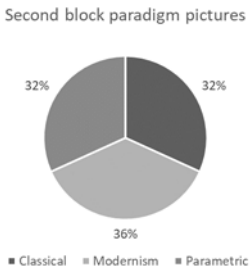


Fig. 53. Second block answer by author

In the figure No. 51 modernism building represent a higher value rather the classical and parametric that shared the same score.

Fig. 54. Third block paradigm pictures by author

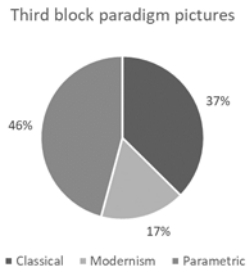


Fig. 55. Third block answer by author

This option shows the tendency to the parametric building is the most appealing followed by the classical and the modernism at last.

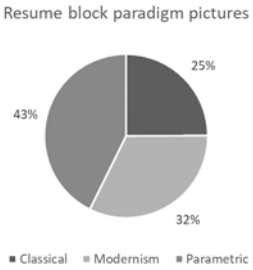


Fig. 56. Resume block paradigm picture by author

In resume the most appealing paradigm overall is the parametric from the figure 54 followed by the modernism and the last one the classical, this reveal that under the audience the understanding from aesthetics is influenced by the technological trending and organic forms.

– Building's composition element identification scores

This section provides the capacity from the audience sample to understand from the aesthetics composition elements the measure from the first composition features identification from each building, in this section is denotated that some composition features are more comprehensive rather to others.

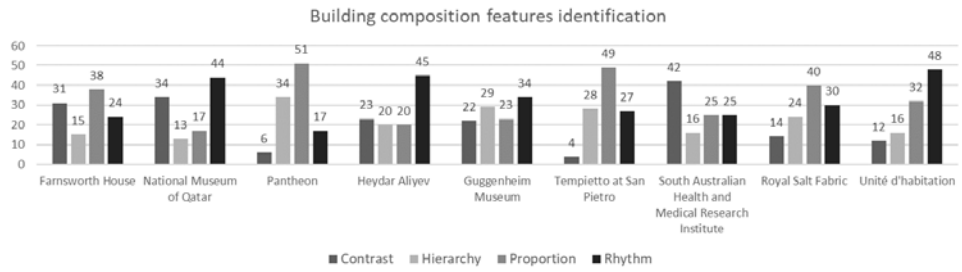


Fig. 57. Aesthetics identification answer by author

From the figure 55 the classical paradigm demonstrates the importance from the proportion aspect from the buildings, followed by the hierarchy, rhythm, and last contrast, this confirm that the audience perceive the nature influence in the building composition overall. The modernism paradigm in general tend to show rhythm as the first element in general, followed by the proportion, hierarchy, and contrast, in the samples pictures the rhythm is notable in absence of detailed décor elements from the buildings and its relevant to mention that proportions still represent a valuable identification because from the classicism to modernism paradigms proportions establishment maintain the same basis. The parametric buildings reveal the rhythm as the first composition identified by the sample, followed by the contrast from the façade configuration that shows an organic form, followed by the proportion this is connected by the position from organic features proportions follows mathematical patterns (Amal Osama, Fractal geometry in architecture: from formative idea to superficial skin design, 2014), and hierarchy.

– Building's composition element scores

Considering that the aesthetics can be easily identified is measured a possible score unit from 1 to 4 evaluation criterion from the composition features in equivalence that 1 is the lowest score and 4 the higher.

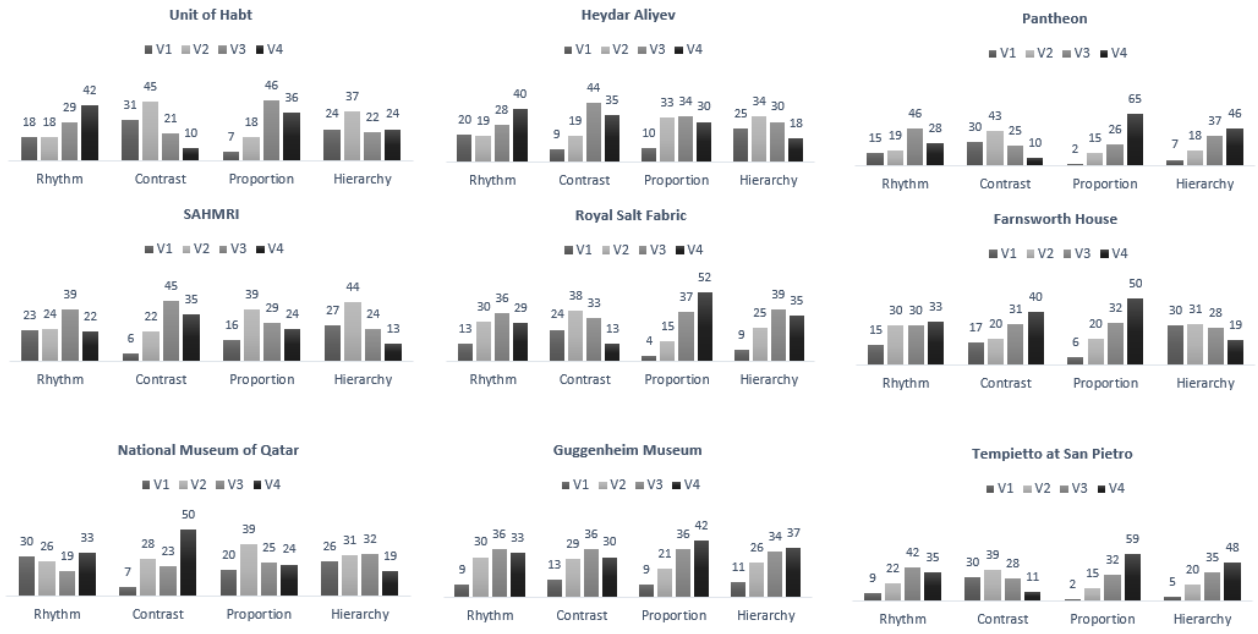


Fig. 58. Aesthetics score by author

The figure 56 shows that the particularity from each building in contrast related with the composition highest score, nevertheless the score is a generalize idea from the impression that the building could have, in this part the valorization reveals the level of significance from each building sample.

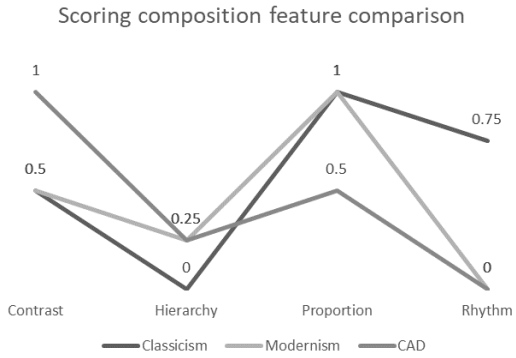


Fig. 59. Scoring paradigm composition features comparison by author

Translating the information from the previous collection of information, the value with 4 that is higher is replaced by the value of 1, meaning that each value corresponds to 1 the V4, 0.75 the V3, 0.5 the V2 and 0.25 to the V1. This scale provides a clear understanding where proportion leads, followed by contrast, rhythm, and last hierarchy. This show the audience give more importance how well-proportioned the object, nevertheless in all the figures samples it was not mention where the contrast was applied or presented, it will not conclude as a relevant due to the magnitude from its, nevertheless the rhythm that could be through the windows, pillar or other elements that shows these features and the last one reveal an interesting pattern about hierarchy where is not well identified and scored at the same time, concluding an interesting path over the nine buildings that is clear and reveal the higher value that a building could have.

This information between the score and the identification is represented over the next table to observe the similarities and incongruences.

Table 7. Composition features comparison table by author

Example name	Criterion	Identification	V1	V2	V3	V4
Unit of Habt	Rhythm	48	18	18	29	42
	Contrast	12	31	45	21	10
	Proportion	32	7	18	46	36
	Hierarchy	16	24	37	22	24
Heydar Aliyev	Rhythm	45	20	19	28	40
	Contrast	23	9	19	44	35
	Proportion	20	10	33	34	30
	Hierarchy	20	25	34	30	18
Pantheon	Rhythm	17	15	19	46	28
	Contrast	6	30	43	25	10
	Proportion	51	2	15	26	65
	Hierarchy	34	7	18	37	46
SAHMRI	Rhythm	25	23	24	39	22
	Contrast	42	6	22	45	35
	Proportion	25	16	39	29	24

	Hierarchy	16	27	44	24	13
Royal Salt Fabric	Rhythm	30	13	30	36	29
	Contrast	14	24	38	33	13
	Proportion	40	4	15	37	52
	Hierarchy	24	9	25	39	35
Farnsworth House	Rhythm	24	15	30	30	33
	Contrast	31	17	20	31	40
	Proportion	38	6	20	32	50
	Hierarchy	15	30	31	28	19
National Museum of Qatar	Rhythm	44	30	26	19	33
	Contrast	34	7	28	23	50
	Proportion	17	20	39	25	24
	Hierarchy	13	26	31	32	19
Guggenheim Museum	Rhythm	34	9	30	36	33
	Contrast	22	13	29	36	30
	Proportion	23	9	21	36	42
	Hierarchy	29	11	26	34	37
Tempietto at San Pietro	Rhythm	27	9	22	42	35
	Contrast	4	30	39	28	11
	Proportion	49	2	15	32	59
	Hierarchy	28	5	20	35	48

From the previous table it is appreciated the quantitative data from the composition features that the audience selected in comparison with the score from them, the selection through the pictures was random with the objective to not to track the same picture after the selection, for that reason randomization was important over the questionnaire.

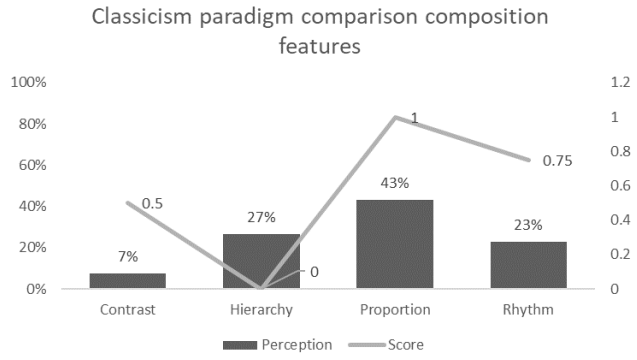


Fig. 60. Classicism paradigm data comparison by author

In the figure 60 the audience perceived the proportion as the higher feature in all the buildings that and at the same time is the highest scored, unfortunately, hierarchy was clearly perceived, but not scored meaning that in this building the features are identified but lost its value over the other ones, rhythm slightly correspond and contrast in the last order. This reveals the following order: proportion, rhythm, contrast, and last hierarchy revealing that the nature and human relationship are distinguished in this paradigm.

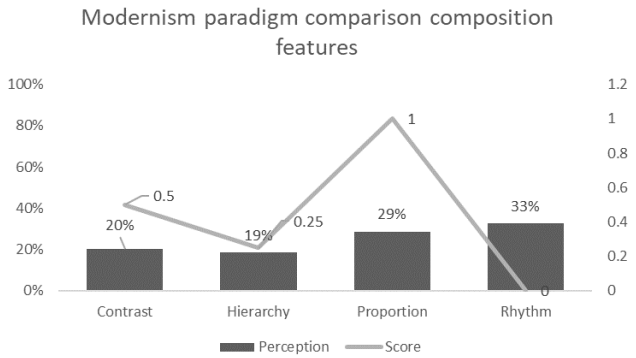


Fig. 61. Modernism paradigm data comparison by author

In the figure 61 the audience respond slightly similar to the previous chart but in this case, they perceived the rhythm as the highest valuable feature but at the moment to evaluate it did not receive a valuable score in contrast with the second higher feature corresponding to proportion that match with the higher score from the answers followed by contrast and last hierarchy. Until now it can be concluded that in these buildings the feature of three elements is quite close but obtained relevance in the scoring This reveals the following order: proportion, contrast, hierarchy, and last rhythm this order in this paradigm tend to maintain a connection with classicism in the sense of proportion and contrast had a higher importance but is relevant that hierarchy is identified even though that some figures from the sample did not show a relevant volume on them.

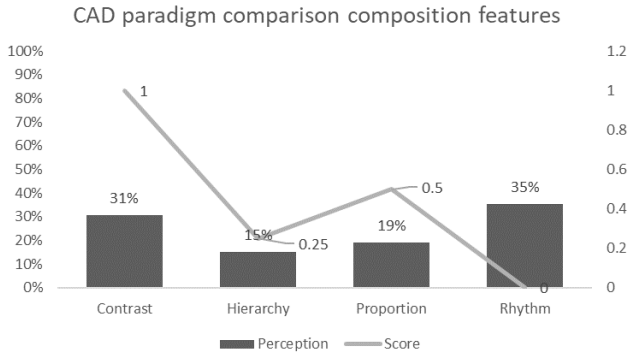


Fig. 62. CAD paradigm data comparison by author

From the figure 62 the feature contrast acquired a higher score and slightly correspond to identification, followed by proportion scored in the third position, hierarchy goes into the third position and the last scored correspond to rhythm. In this graphic, rhythm can’t be excluded, but the exclusion of this element shows a pattern that correspond with the previous paradigms.

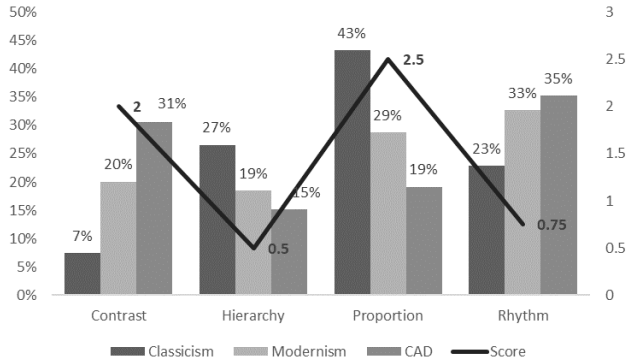


Fig. 63. Resume graphic comparison between identification and score by author

In the figure 63 the tendency shows from all the samples that proportion is the first appreciated and scored by the audience, the second one is contrast, third is rhythm and the last one is hierarchy. In terms of generalizations paradigms reveal the same pattern from the data collected.

2.4. Analysis of facades samples using space syntax methodology

In this chapter the tool space syntax it was used because provides the method to analyze and describe the relationships between the spaces providing a data base, based on space measures and topology analysis. The space syntax works along the term “spaces” that means that is articulated with voids, streets, rooms, and other ones, from the examination in the building façade analysis the voids were proposed by the representation from windows, doors, porticos, or other space that the façade could had, restricting the visual frame from their compound. Space syntax has 3 basic conceptions: convex space, axial space and isovits space (Klarqvist, 1993).

Space syntax tool as it was mentioned before work based on the space, and subsequently the analysis relates to different types of space analysis such as (Klarqvist, 1993):

- Convex space is the space where any line crosses the perimeter between any two of its points without going outside of the boundary of its space (Claudia Yamu, 2021).
- Axial space is a straight line that represent a path inside the system.
- Isovits space is the area observed from a specific point.

Table 8. Comparison between convex map space and axial map space by author

Type of analysis	Axial map analysis		Convex map analysis	
	Advantages	Disadvantages	Advantages	Disadvantages
Observations	Less area of surface. Quicker to measure. Represent the element in a free disposition.	Sensitivity over the line distance. Small section lines tend to difficult the visualization. Implied many biases.	Represent an integrated image from the façade. Values and result data covered the hole area of the analysis.	Requires more time to do the splitting part of convex cells. Convex cells tend to represent sub sections under previous identification of elements. Lines for analysis should not crosse between cells restricting the movement between cells.

The previous table provide the insight among the timeline and scope that axial map space is the most accurate in terms of time, resources, and represents a better cognitive representation from the people navigating in the space (Ashley Dhanani, 2012).

An axial map is defined by the least or minimal axial lines passing through each convex space generating axial links between the nodes in the hole system (Bill Hillier, 1984) meanwhile, an axial line is the longer line, drawn over an arbitrary point in the space and the convex space is defined by a convex polygon around a point. The essence from axial map is the maximum line links.

Axial maps analysis depends directly on the number of axial lines covering all convex spaces and connections in the space (Ashley Dhanani, 2012). From axial maps it is possible to obtain syntactic measures such as connectivity, integration, and choice.

- Connectivity stablishes the quantity of neighbors that are directly connected to a space.
- Integration is the average depth of a space in relationship to all the spaces in the system, allowing to be ranked from the most segregated to the most integrated.
- Choice reflects the flow and path in the space.

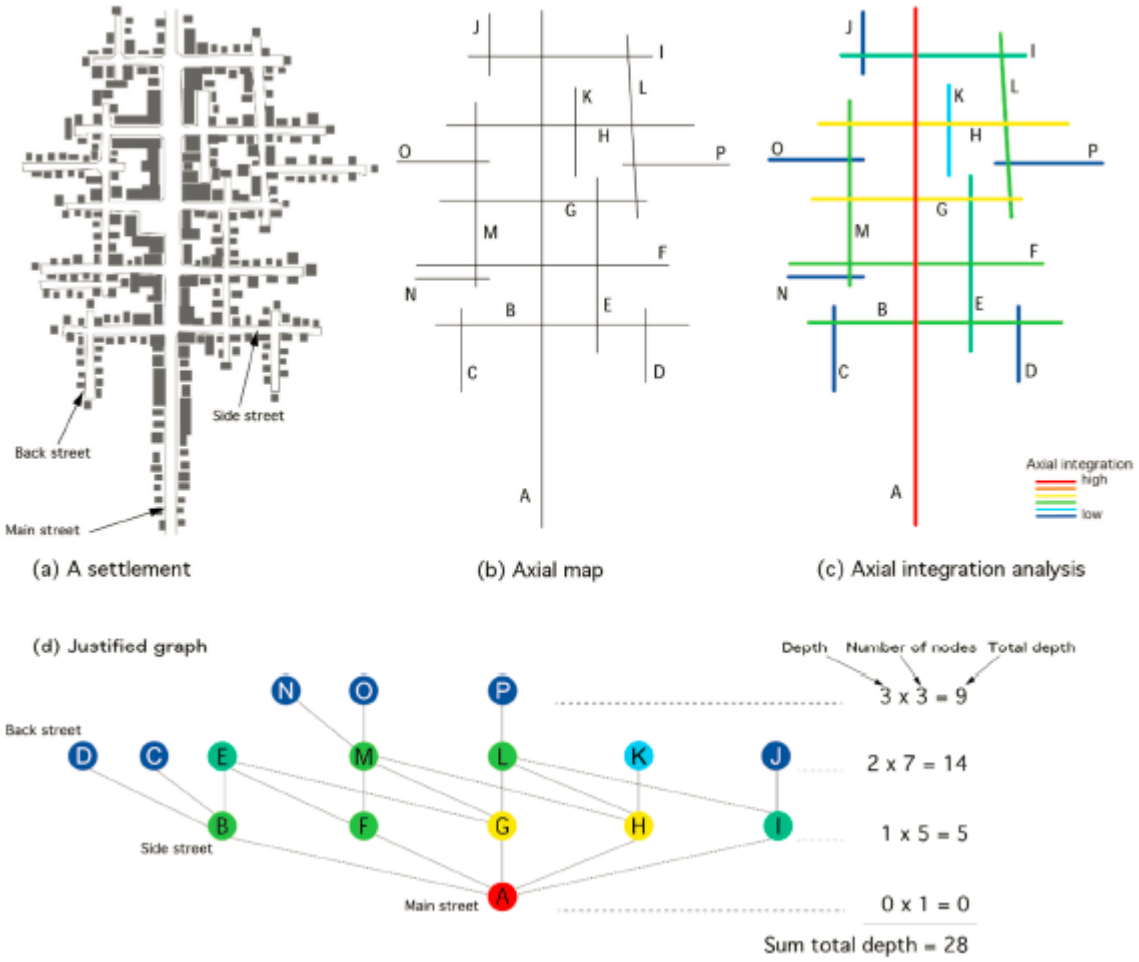


Fig. 64. Axial map representation (Claudia Yamu, 2021)

The previous shows the axial map analysis procedure, starting from the identification of elements (a, b), the value integration (c), and the justified graph that is the total depth from each integrated element, were the lines that had a high number of nodes from the root node to the final is topologically deep.

The previous explanation prepared the path to use the CAD tools, starting with the 3D model's availability in the 3D warehouse. The procedures started setting the position of the viewer to observe a wider frame where the buildings could be appreciated, it was not considering an orthogonal frontal elevation as the previous cases studies due to it was necessary to explore a normal visualization from a viewer appreciating any building, this point of view is mentioned by Emo through the capacity of wayfinding behavior from users in general (Emo, 2014), after the frame's selection, they were exported to CAD, in the CAD software over, each case, axial lines were draw it over each element that is representative, each façade was exported to depth map to proceed with each analysis under certain parameters.

Table 9. Distance from point of view by author

Model	Height POV (meters)	Distance (meters)
The Pantheon	1.70	99
The Royalt Salt Fabric		60
San Pietro Church		31
The Gugenheim Museum		65
The Fanrsworth House		35
Unite d'Habitation Marsellas		125
Heydar Aliyev Center		114
National Museum of Quatar		124
South Australian Health and Medical Research Institute		111

The position from each building refers where the façade is well perceived to conduct the drawing under the visual frame, in this part, it is decided to create cross lines in each representative element from the building's façade, for example columns and their sub segments, including windows and doors.

2.4.1. Axial lines analysis on building facades

The use of axial lines provides a better opportunity to differentiate the elements from a façade in this case the drawing of a line representing one element is the method to measure the influence of this, because in terms of interpretation the element that could be a column or other relevant aspect from the facade is an element from the interrelation between the hole compound, in this case it was described through a line to run the analysis, although Hillier mentioned in terms of analysis each line represent a node and each intersection represent a vertex (Bill Hillier, 1984).

Fron the nodes an intersection from each line represents a linear space (Xintao Liu, 2012) in the model and axial lines analysis performs the measurement for accessibility to that linear space. The axial map from the layout is the compound from the minimum amount of longest straight lines needed to cover each space from the layout without crossing any physical object (Bill Hillier, 1984), for that reason, each line drawing on the cad façade is an axial line and the compound of them is the axial map (Mahbub Rashid, 2006).

Nevertheless, two map options were tested axial map analysis and segment map analysis, considering that the intention from this study is to distinguish other ways to do façade analysis reinterpretation with the purpose to compare and complement the previous analysis made it by Hillier over convex façades.

Under the depth map tool, the data provided (CAD drawing) was tested under the value of radius No. 3, selecting choice, integration, and connectivity to explore how the lines and nodes could represent the topological path over the nine building facades.

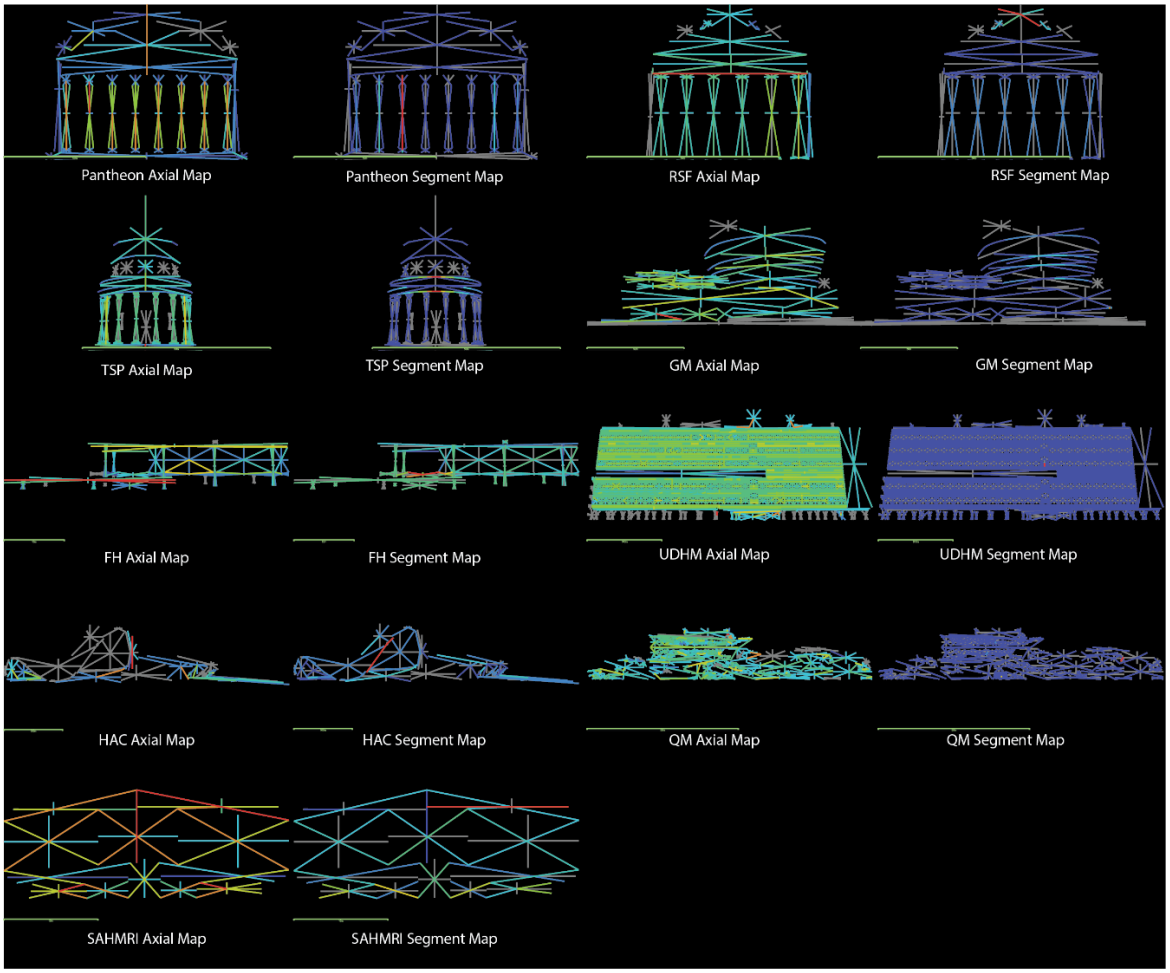


Fig. 65. Axial analysis over façade samples by author

Axial analysis shows a correspondence and higher number of interconnections in different areas from the façade, revealing a particular pattern from each case under the axial and segmented map, even though red lines show the higher integration in the map, other lines acquire a higher value over the conjunction of them. Over the position in the CAD facades, from the integration areas some attributes are identified such as hierarchy and rhythm demonstrating a relation.

Table 10. Analysis of visual information from the façade analysis by author

	Axial Map		Segment Map	
Building Facade	Integration Area	Composition correspondence	Integration Area	Composition correspondence
The Pantheon	Columns	Rhythm	Columns	Rhythm
The Royalt Salt Fabric	Tympanum	Hierarchy	Roof tympanum	Hierarchy
San Pietro Church	Columns	Rhythm	Cornice ring	Rhythm
The Gugenheim Museum	Rings	Rhythm	Rings	Rhythm
The Fanrsworth House	Stairs	-	Entrance	-
Unite d'Habitation Marsellas	Entrance bottom	Hierarchy	Stair's area	Hierarchy
Heydar Aliyev Center	Curtain wall	Hierarchy	Curtain wall	Hierarchy
National Museum of Quatar	Top area	-	Left area	-
South Australian Health and Medical Research Institute	Top area	-	Top area	-

From the visual analysis some buildings match in the integration results, without the quantity of integrated nodes, however from some buildings was not possible to identify a pattern that is interpretated as a composition attribute, nevertheless the analysis from the integration values were extracted for further comparison, as a result, the data extracted from the analysis was merged with the scoring part from the survey resulting in the following table:

Table 11. Axial map data information by author

Building	Axial Corelation	Choice	Int	IntR3	IntR3Max	IntR3Av	IntR3Min	IntxIntR3	IntxIntMax	IntxIntAV	IntxIntMin	Node Count	Connectivity	Score
Pantheon	0.968428	32.172700	1.092230	1.040220	5.222900	2.119760	0.985580	1.136159	5.704608	2.315265	1.076480	3.468000	11.393500	34.000000
Royal Salt Fabric	0.870336	218.659000	0.639227	0.555958	4.608310	1.773940	0.333333	0.355383	2.945756	1.133950	0.213075	20.609300	105.363000	7.000000
San Pietro	0.623668	272.302000	0.924159	0.747611	5.094740	1.802140	0.333333	0.690911	4.708350	1.665464	0.308053	18.229500	59.917600	18.000000
Gugenheimn	0.389460	436.043000	0.478843	0.547097	3.666670	1.261310	0.333333	0.261974	1.755759	0.603969	0.159614	19.686700	79.341500	39.000000
Farnsworth	0.517664	532.036000	0.672504	0.540777	3.883180	1.894000	1.020790	0.363675	2.611454	1.273723	0.686485	35.453700	1.726810	47.000000
Unite d'Habitacion	0.000797	484703.000000	0.209794	0.219495	3.490230	1.948370	0.727820	0.046049	0.732229	0.408756	0.152692	1240.320000	0.770758	40.000000
Heydar Aliyev center	0.599592	69.790500	0.549303	0.451173	3.490230	1.646150	1.018950	0.247831	1.917194	0.904235	0.559712	9.599970	0.718144	54.000000
National Museum of Qatar	0.074360	4346.550000	0.388154	0.335456	3.490230	1.672410	0.727820	0.130209	1.354747	0.649153	0.282506	117.493000	1.004940	35.000000
SHAMRI	0.405367	205.848000	0.205649	0.332976	2.500000	1.768740	1.359220	0.068476	0.514123	0.363740	0.279522	0.014082	1.374510	50.000000

Table 12. Segment map data information by author

Building	Segment Corelation	Choice	Int	IntR3	IntR3Max	IntR3Av	IntR3Min	IntxIntR3	IntxIntMax	IntxIntAV	IntxIntMin	Node Count	Connectivity	Score
Pantheon	1.000000	4.568410	765.910000	765.910000	4096.000000	282.137000	2.711390	586618.128100	3137167.360000	216091.549670	2076.680715	2.237810	1.382550	34.000000
Royal Salt Fabric	1.000000	1.506400	3.229060	3.229060	19.692300	4.777180	2.812700	2473.169345	15082.529493	3658.889934	2154.275057	1.867960	7.299210	7.000000
San Pietro	0.614175	50.288000	29.794900	76.740300	348.444000	39.820400	1.777010	2286.469564	10381.854136	1186.444836	52.945835	7.275380	17.571300	18.000000
Gugenheimn	0.179306	337.917000	82.495300	253.138000	2212.570000	188.776000	2.663340	20882.695251	182526.625921	15573.132753	219.713032	19.678000	40.223900	39.000000
Farnsworth	0.924277	17.464900	1.612800	1.773610	15.574100	7.841030	2.741230	2.860478	25.117908	12.646013	4.421056	4.883340	1.646300	47.000000
Unite d'Habitacion	0.966822	177278.000000	127.357000	127.102000	4096.000000	15.044500	1.508840	16187.329414	521654.272000	1916.022387	192.161336	1417.510000	1.674940	40.000000
Heydar Aliyev center	0.999008	14.882200	3.938070	3.937920	34.133300	7.891970	3.289960	15.507805	134.419325	31.079130	12.956093	4.247610	1.488030	54.000000
National Museum of Qatar	0.967557	970.125000	18.813900	18.633600	256.000000	9.606920	2.270510	350.570687	4816.358400	180.743632	42.717148	48.577300	1.748800	35.000000
SHAMRI	0.044497	160.454000	0.962291	1.815820	11.985000	6.485380	3.370230	1.747347	11.533058	6.240823	3.243142	14.646900	1.522100	50.000000

The table No.11 and No. 12 is presented with the first column with the correlation factor from the integration score and the integration radius 3 as measurement tools, this correlation factor demonstrate the core of how integrate are the lines from the façade elements. After the first column it was considered for the analysis the choice, the minimum integration, the average integration, the maximum integration, the number of nodes and the connectivity index.

2.5. Comparison between results of façade space syntax analysis and sociological survey

From the paradigms in general, implementing axial map analysis over the 9 facades it was obtained that the classicism paradigm represents a higher index of correlation through axial map in comparison with the segment map results; the modernism paradigm presented a higher correlation from the segment map analysis rather than the axial map where only one building shows a correlation index acceptable; and with the parametric paradigm, the segment map showed a higher score in comparison of axial analysis.

The results demonstrate from one direction the sensitivity from each building element, for that reason firstly the axial analysis was compared with the most recognizable element from the survey and secondly correlated with the survey data about the most interesting building.

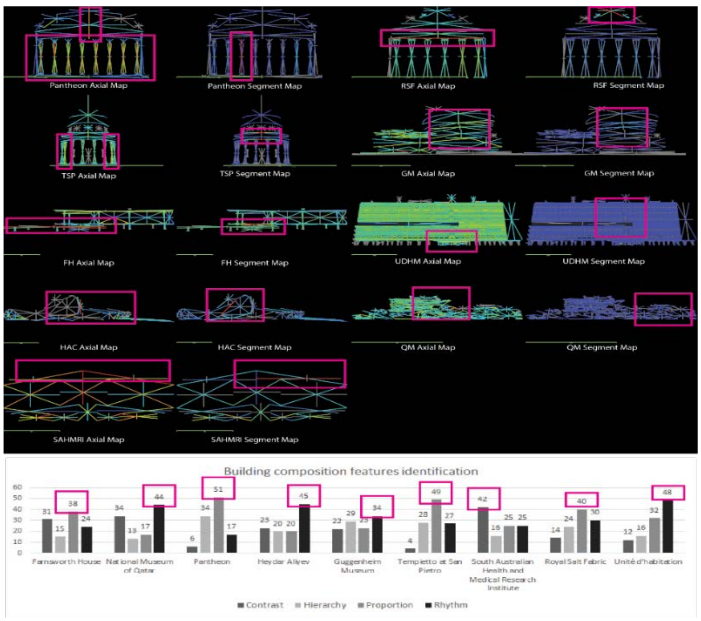


Fig. 66. Visual comparison from the axial map and the features identification by author

From the previous figure was possible to observe the tendency from the survey data, the information was extracted to the following table:

Table 13. Comparison table between the integration visual information and the survey identification by author

Building Facade	Axial Map		Segment Map		Survey identification
	Integration Area	Composition correspondence	Integration Area	Composition correspondence	
The Pantheon	Columns	Rhythm	Columns	Rhythm	Proportion
The Royalt Salt Fabric	Tympanum	Hierarchy	Roof tympanum	Hierarchy	Proportion
San Pietro Church	Columns	Rhythm	Cornice ring	Rhythm	Proportion
The Gugenheim Museum	Rings	Rhythm	Rings	Rhythm	Rhythm
The Fanrsworth House	Stairs	-	Entrance	-	Proportion
Unite d'Habitation Marsellas	Entrance bottom	Hierarchy	Stair's area	Hierarchy	Rhythm
Heydar Aliyev Center	Curtain wall	Hierarchy	Curtain wall	Hierarchy	Rhythm
National Museum of Quatar	Top area	-	Left area	-	Rhythm
South Australian Health and Medical Research Institute	Top area	-	Top area	-	Contrast

From the table before most data collected differs in terms of identification and composition correspondence, from the list only one building demonstrated the same pattern and same identification by the users in the survey, however some of the composition correspondences were not clear at the moment of the visual analysis besides some composition attributes were not easy to correspondence with the space syntax results such as contrast, due to the tool or the procedures did not provide a clear statement to obtained it. Nevertheless, this analysis demonstrates coming from the segment and axial analysis the pattern match such is the case from 5 facades of 9 in total.

Table 14. Correlations factors from axial maps and scoring from survey by author

Correlations

		Axial Corelation	Choice	Int	IntR3	IntR3Max	IntR3Av	IntR3Min	IntxIntR3	IntxIntMax	IntxIntAV	IntxIntMin	Node Count	Connectivity	Segment Corelation	Choice	Int	IntR3	IntR3Max	IntR3Av	IntR3Min	IntxIntR3	IntxIntMax	IntxIntAV	IntxIntMin	Node Count	Connectivity	Score
Axial Corelation	Pearson Correlation	1	-0.579	.796**	.819**	.673*	.273	-0.057	.762*	.777*	.780*	0.592	-0.621	0.411	0.152	-0.577	0.451	0.430	-0.080	0.420	0.437	0.537	0.457	0.551	.715*	-0.595	-0.002	-0.387
	Sig. (2-tailed)		0.103	0.010	0.007	0.047	0.478	0.884	0.017	0.014	0.013	0.093	0.074	0.272	0.695	0.104	0.223	0.248	0.838	0.261	0.240	0.136	0.216	0.125	0.031	0.091	0.997	0.303
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Choice	Pearson Correlation	-0.579	1	-0.458	-0.475	-0.193	0.287	-0.033	-0.348	-0.374	-0.369	-0.320	.991**	-0.260	0.222	1.000**	0.017	-0.020	0.606	-0.178	-0.641	-0.106	0.032	-0.131	-0.142	1.000**	-0.190	0.099
	Sig. (2-tailed)	0.103		0.215	0.197	0.618	0.454	0.932	0.358	0.321	0.329	0.401	0.000	0.499	0.566	0.000	0.965	0.959	0.083	0.648	0.063	0.787	0.936	0.736	0.715	0.000	0.624	0.800
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Int	Pearson Correlation	.796*	-0.458	1	.956**	.912**	0.368	-0.230	.952**	.987**	.979**	.693*	-0.475	0.260	0.334	-0.457	0.589	0.586	0.118	0.551	-0.034	0.640	0.577	0.648	0.526	-0.470	0.070	-0.422
	Sig. (2-tailed)	0.010	0.215		0.000	0.001	0.330	0.552	0.000	0.000	0.000	0.039	0.196	0.500	0.379	0.216	0.095	0.098	0.762	0.124	0.931	0.063	0.103	0.059	0.146	0.202	0.858	0.258
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3	Pearson Correlation	.819**	-0.475	.956**	1	.843**	0.322	-0.158	.981**	.959**	.946**	.709*	-0.501	0.273	0.142	-0.474	.724*	.746*	0.251	.737*	0.067	.770*	.709*	.783*	0.594	-0.486	0.160	-0.359
	Sig. (2-tailed)	0.007	0.197	0.000		0.004	0.397	0.684	0.000	0.000	0.000	0.033	0.169	0.477	0.716	0.198	0.027	0.021	0.515	0.024	0.864	0.015	0.032	0.013	0.091	0.185	0.682	0.343
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Max	Pearson Correlation	.673*	-0.193	.912**	.843**	1	0.383	-0.514	.864**	.939**	.890**	0.441	-0.204	0.449	0.444	-0.193	0.533	0.533	0.249	0.471	-0.335	0.546	0.520	0.551	0.629	-0.204	0.125	-.692*
	Sig. (2-tailed)	0.047	0.618	0.001	0.004		0.309	0.157	0.003	0.000	0.001	0.235	0.599	0.226	0.231	0.619	0.140	0.140	0.519	0.200	0.378	0.128	0.151	0.124	0.070	0.598	0.748	0.039
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Av	Pearson Correlation	0.273	0.287	0.368	0.322	0.383	1	0.394	0.472	0.435	0.540	0.579	0.274	-0.416	0.530	0.286	0.534	0.353	0.319	0.043	-0.211	0.542*	0.569*	0.509	0.393	0.276	-.755*	-0.104
	Sig. (2-tailed)	0.478	0.454	0.330	0.397	0.309		0.294	0.199	0.241	0.134	0.102	0.475	0.265	0.143	0.455	0.139	0.351	0.402	0.912	0.585	0.131	0.110	0.161	0.295	0.472	0.019	0.791
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Min	Pearson Correlation	-0.057	-0.033	-0.230	-0.158	-0.514	0.394	1	-0.104	-0.252	-0.095	0.473	-0.047	-.826**	-0.067	-0.033	0.165	0.039	-0.057	-0.096	0.531	0.211	0.198	0.190	-0.213	-0.035	-0.666	.762*
	Sig. (2-tailed)	0.884	0.932	0.552	0.684	0.157	0.294		0.789	0.512	0.809	0.198	0.905	0.006	0.863	0.932	0.672	0.921	0.884	0.806	0.141	0.586	0.610	0.625	0.583	0.930	0.050	0.017
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntR3	Pearson Correlation	.762*	-0.348	.952**	.981**	.864**	0.472	-0.104	1	.973**	.973**	.750*	-0.372	0.155	0.250	-0.348	.788*	.778*	0.335	.709*	-0.043	.823**	.777**	.828**	0.593	-0.359	0.024	-0.350
	Sig. (2-tailed)	0.017	0.358	0.000	0.000	0.003	0.199	0.789		0.000	0.000	0.020	0.324	0.691	0.516	0.359	0.012	0.013	0.378	0.033	0.913	0.006	0.014	0.006	0.092	0.342	0.951	0.356
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntMax	Pearson Correlation	.777**	-0.374	.987**	.959**	.939**	0.435	-0.252	.973**	1	.982**	0.653	-0.394	0.275	0.315	-0.374	0.643	0.634	0.202	0.573	-0.117	.683*	0.632	.688*	0.576	-0.386	0.054	-0.491
	Sig. (2-tailed)	0.014	0.321	0.000	0.000	0.000	0.241	0.512	0.000		0.000	0.057	0.294	0.474	0.409	0.321	0.062	0.067	0.603	0.107	0.763	0.043	0.068	0.040	0.105	0.304	0.890	0.180
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntAV	Pearson Correlation	.780*	-0.369	.979**	.946**	.890**	0.540	-0.095	.973**	.982**	1	.775*	-0.387	0.128	0.394	-0.368	.688*	0.648	0.202	0.554	-0.045	.736*	.684*	.737*	0.575	-0.381	-0.094	-0.377
	Sig. (2-tailed)	0.013	0.329	0.000	0.000	0.001	0.134	0.809	0.000	0.000		0.014	0.304	0.743	0.294	0.329	0.041	0.059	0.602	0.121	0.908	0.024	0.042	0.024	0.105	0.311	0.810	0.318
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntMin	Pearson Correlation	0.592	-0.320	.693*	.709*	0.441	0.579	0.473	.750*	0.653	.775*	1	-0.337	-0.395	0.395	-0.320	.736*	0.653	0.236	0.528	0.304	.795*	.749*	.788*	0.375	-0.330	-0.397	0.228
	Sig. (2-tailed)	0.093	0.401	0.039	0.033	0.235	0.102	0.198	0.020	0.057	0.014		0.375	0.293	0.293	0.401	0.024	0.057	0.541	0.144	0.427	0.010	0.020	0.012	0.320	0.385	0.290	0.556
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Node Count	Pearson Correlation	-0.621	.997**	-0.475	-0.501	-0.204	0.274	-0.047	-0.372	-0.394	-0.387	-0.337	1	-0.274	0.247	.997**	-0.004	-0.043	0.588	-0.200	-0.665	-0.127	0.010	-0.153	-0.162	.998**	-0.200	0.092
	Sig. (2-tailed)	0.074	0.000	0.196	0.169	0.599	0.475	0.905	0.324	0.294	0.304	0.375		0.475	0.522	0.000	0.992	0.913	0.096	0.605	0.051	0.745	0.980	0.695	0.678	0.000	0.606	0.813
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Connectivity	Pearson Correlation	0.411	-0.260	0.260	0.273	0.449	-0.416	-.826**	0.155	0.275	0.128	-0.395	-0.274	1	-0.182	-0.259	-0.154	-0.031	-0.127	0.144	-0.061	-0.149	-0.176	-0.119	0.448	-0.265	0.665	-.776**
	Sig. (2-tailed)	0.272	0.499	0.500	0.477	0.226	0.265	0.006	0.691	0.474	0.743	0.293	0.475		0.639	0.501	0.693	0.937	0.745	0.713	0.876	0.701	0.650	0.761	0.226	0.491	0.051	0.014
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Segment Corelation	Pearson Correlation	0.152	0.222	0.334	0.142	0.444	0.530	-0.067	0.250	0.315	0.394	0.395	0.247	-0.182	1	0.220	0.239	0.101	0.136	-0.110	-0.264	0.242	0.262	0.221	0.367	0.216	-0.562	-0.214
	Sig. (2-tailed)	0.695	0.566	0.379	0.716	0.231	0.143	0.863	0.516	0.409	0.294	0.293	0.522	0.639		0.570	0.537	0.796	0.726	0.778	0.493	0.531	0.496	0.568	0.331	0.577	0.115	0.580
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Choice	Pearson Correlation	-0.577	1.000**	-0.457	-0.474	-0.193	0.286	-0.033	-0.348	-0.374	-0.368	-0.320	.997**	-0.259	0.220	1	0.018	-0.019	0.607	-0.176	-0.639	-0.105	0.032	-0.131	-0.142	1.000**	-0.189	0.099
	Sig. (2-tailed)	0.104	0.000	0.216	0.198	0.619	0.455	0.932	0.359	0.321	0.329	0.401	0.000	0.501	0.570		0.964	0.961	0.083	0.650	0.064	0.788	0.935	0.738	0.716	0.000	0.627	0.799
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Int	Pearson Correlation	0.451	0.017	0.589	.724*	0.533	0.534	0.165	.788*	0.643	.688*	.736*	-0.004	-0.154	0.239	0.018	1	.974**	.737*	.847**	-0.037	.990**	.998**	.988**	0.611	0.013	-0.130	-0.044
	Sig. (2-tailed)	0.223	0.965	0.095	0.027	0.140	0.139	0.672	0.012	0.062	0.041	0.024	0.992	0.693	0.537	0.964		0.000	0.024	0.004	0.925	0.000	0.000	0.000	0.080	0.977	0.739	0.911
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3	Pearson Correlation	0.430	-0.020	0.586	.746*	0.533	0.353	0.039	.778*	0.634	0.648	0.653	-0.043	-0.031	0.101	-0.019	.974**	1	.767*	.942**	-0.053	.963**	.961**	.959**	0.565	-0.025	0.095	-0.054
	Sig. (2-tailed)	0.248	0.959	0.098	0.021	0.140	0.351	0.921	0.013	0.067	0.059	0.057	0.913	0.937	0.796	0.961	0.000		0.016	0.000	0.892	0.000	0.000	0.000	0.113	0.949	0.807	0.890
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Max	Pearson Correlation	-0.080	0.606	0.118	0.251	0.249	0.319	-0.057	0.335	0.202	0.202	0.236	0.588	-0.127	0.136	0.607	.737*	.767*	1	.669*	-0.441	0.635	.730*	0.629	0.312	0.604	0.089	0.041
	Sig. (2-tailed)	0.838	0.083	0.762	0.515	0.519	0.402	0.884	0.378	0.603	0.602	0.541	0.096	0.745	0.726	0.083	0.024	0.016		0.049	0.235	0.066	0.026	0.069	0.413	0.085	0.820	0.917
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Av	Pearson Correlation	0.420	-0.178	0.551	.737*	0.471	0.043	-0.096	.709*	0.573	0.554	0.528	-0.200	0.144	-0.110	-0.176	.841**	.942**	.669*	1	0.039	.830**	.822**	.850**	0.472	-0.180	0.389	-0.039
	Sig. (2-tailed)	0.261	0.648	0.124	0.024	0.200	0.912	0.806	0.033	0.107	0.121	0.144	0.605	0.713	0.778	0.650	0.004	0.000	0.049		0.922	0.006	0.007	0.004	0.199	0.643	0.301	0.920
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntR3Min	Pearson Correlation	0.437	-0.641	-0.034	0.067	-0.335	-0.211	0.531	-0.043	-0.117	-0.045	0.304	-0.665	-0.061	-0.264	-0.639	-0.037	-0.053	-0.441	0.039	1	0.067	-0.020	0.083	0.129	-0.645	-0.123	0.388
	Sig. (2-tailed)	0.240	0.063	0.931	0.864	0.378	0.585	0.141	0.913	0.763	0.908	0.427	0.051	0.876	0.493	0.064	0.925	0.892	0.235	0.922		0.863	0.958	0.832	0.740	0.061	0.752	0.303
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntR3	Pearson Correlation	0.537	-0.106	0.640	.770*	0.546	0.542	0.211	.823**	.683*	.736*	.795**	-0.127	-0.149	0.242	-0.105	.990**	.953**	0.635	.830**	0.067	1	.990**	.999**	0.641	-0.112	-0.171	-0.049
	Sig. (2-tailed)	0.136	0.787	0.063	0.015	0.128	0.131	0.586	0.006	0.043	0.024	0.010	0.745	0.701	0.531	0.788	0.000	0.000	0.066	0.006	0.863		0.000	0.000	0.063	0.774	0.661	0.900
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntMax	Pearson Correlation	0.457	0.032	0.577	.709*	0.520	0.569	0.198	.777**	0.632	.684*	.749*	0.010	-0.176	0.262	0.032	.998**	.961**	.730*	.822**	-0.020	.990**	1	.987**	0.624	0.025	-0.178	-0.034
	Sig. (2-tailed)	0.216	0.936	0.103	0.032	0.151	0.110	0.610	0.014	0.068	0.042	0.020	0.980	0.650	0.496	0.935	0.000	0.000	0.026	0.007	0.958	0.000		0.000	0.073	0.949	0.647	0.930
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntAV	Pearson Correlation	0.551	-0.131	0.648	.783*	0.551	0.509	0.190	.828**	.688*	.737*	.788*	-0.153	-0.119	0.221	-0.131	.988**	.959**	0.629	.850**	0.083	.999**	.987**	1	0.649	-0.138	-0.134	-0.058
	Sig. (2-tailed)	0.125	0.736	0.059	0.013	0.124	0.161	0.625	0.006	0.040	0.024	0.012	0.695	0.761	0.568	0.738	0.000	0.000	0.069	0.004	0.832	0.000	0.000		0.058	0.724	0.732	0.881
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
IntxIntMin	Pearson Correlation	.715*	-0.142	0.526	0.594	0.629	0.393	-0.213	0.593	0.576	0.575	0.375	-0.162	0.448	0.367	-0.142	0.611	0.565	0.312	0.472	0.129	0.641	0.624	0.649	1	-0.153	-0.112	-0.602
	Sig. (2-tailed)	0.031	0.715	0.146	0.091	0.070	0.295	0.583	0.092	0.105	0.105	0.320	0.678	0.226	0.331	0.716	0.080	0.113	0.413	0.199	0.740	0.063	0.073	0.058		0.695	0.774	0.086
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Node Count	Pearson Correlation	-0.595	1.000**	-0.470	-0.486	-0.204	0.276	-0.035	-0.359	-0.386	-0.381	-0.330	.998**	-0.265	0.216	1.000**	0.011	-0.025	0.604	-0.180	-0.645	-0.112	0.025	-0.138	-0.153	1	-0.186	0.103
	Sig. (2-tailed)	0.091	0.000	0.202	0.185	0.598	0.472	0.930	0.342	0.304	0.311	0.385	0.000	0.491	0.577	0.000	0.977	0.949	0.085	0.643	0.061	0.774	0.949	0.724	0.695		0.631	0.793
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Connectivity	Pearson Correlation	-0.002	-0.190	0.070	0.160	0.125	-.755*	-0.666	0.024	0.054	-0.094	-0.397	-0.200	0.665	-0.562	-0.189	-0.130	0.095	0.089	0.389	-0.123	-0.171	-0.178	-0.134	-0.112	-0.186	1	-0.213
	Sig. (2-tailed)	0.997	0.624	0.858	0.682	0.748	0.019	0.050	0.951	0.890	0.810	0.290	0.606	0.051	0.115	0.627	0.739	0.807	0.820	0.301	0.752	0.661	0.647	0.732	0.774	0.631		0.582
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Score	Pearson Correlation	-0.387	0.099	-0.422	-0.359	**-.692***	-0.104	**.762***	-0.350	-0.491	-0.377	0.228	0.092	**-.776****	-0.214	0.099	-0.044	-0.054	0.041	-0.039	0.388	-0.049	-0.034	-0.058	-0.602	0.103	-0.213	1
	Sig. (2-tailed)	0.303	0.800	0.258	0.343	**0.039**	0.791	**0.017**	0.356	0.180	0.318	0.556	0.813	**0.014**	0.580	0.799	0.911	0.890	0.917	0.920	0.303	0.900	0.930	0.881	0.086	0.793	0.582	
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 15. Significance detail correlations from table 11 by author

Correlations														
		Axial Corelation	Choice	Int	IntR3	IntR3Max	IntR3Av	IntR3Min	IntxIntR3	IntxIntMax	IntxIntAV	IntxIntMin	Node Count	Connectivity
Score	Pearson Correlation	-0.387	0.099	-0.422	-0.359	-.692*	-0.104	.762*	-0.350	-0.491	-0.377	0.228	0.092	-.776**
	Sig. (2-tailed)	0.303	0.800	0.258	0.343	0.039	0.791	0.017	0.356	0.180	0.318	0.556	0.813	0.014
	N	9	9	9	9	9	9	9	9	9	9	9	9	9

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The correlations founded from the table no 14 and 15, but in this case in specific from the table 15 are represented by each terminology in the columns being:

In the case of axial analysis, the integration value, is the result from the depth value, a graph-theoretical measure between the lines using connectivity from the axial map system. At the same time the depth from an axial line is the numbers of steps needed to go over the given axial through all axial lines in the system, giving the value of integration correspondingly with the depth value from the axial line in an inverse relation, where a line with a higher depth value had a lower integration index. This integration index is normalized by the number of axial lines in the system (Mahbub Rashid, 2006).

Meanwhile choice is the relation of each line from all the lines in the system in relation with the lowest total of number of angular deviations. The connectivity value is the number of axial lines that are directed connected to the same line, that means that a value of connectivity from an axial line became higher and the choice of movement through that line became higher in consequence (Mahbub Rashid, 2006).

From the correlations data is possible to ensure that a higher integration value demonstrate a higher connectivity from the façade elements in the buildings, meaning that more is the value from the building more interconnected is with their element, becoming more appealing suggesting that people tend to appreciate in a higher perception the façade elements.

2.6. Conclusion and hypothetical model results based on empirical research

1. As a result, from the investigation and analysis, based on the composition façade patterns using the composition syntax approach, allows to propose the idea that these features can be arranged in a prior order in order to set a further analysis of elements. For that reason, the improvement from the theoretical model is that the information from the façade could be separated and analyzed individually as a conjunction of elements through the buildings.

2. The composition syntax identification is a method that follows the logic of some software to create families of elements and to compound them. In the buildings separate the composition façade patterns indifferent of the hierarchy and order helps to create the possibility of patterns based on visual identification, but it should be known that the façade is not only the result of volumetric features. Due to the final impression of an object came by the result of all their sides in correspondence from the visual frame, planar dimension demonstrates the essence from the surface in order to appreciate other elements in deeper levels, generating the perception in the building.

3. The selection of Space Syntax Method for reinterpretation of façade patterns follows the aim to reveal the composition syntax aspects provided from the definition of a proper CAD scheme because this had a direct influence on the analysis, considering the results obtained in this stage of the research. As a result, in the beginning the use of a net square in a big scale or proportion did not reflect any result, the use of the method of 2 degrees from a distance where the 3d building can be appreciated is a condition because in reality there are two points of view from the users, one is based what the visual range is covered by the user point of view and the one manipulated by the CAD software with the objective to elaborate the proper scheme of analysis.

4. Based on the results from the space syntax in visual frame of identification using the parameter of count of 3 that Hillier proposed, shows an additional pattern that should be carefully classify using a correlation, not in terms of statistics, but based on the results from the sociological survey implementing a further analysis between the appreciation variable from the survey and the building connectivity, providing a new hierarchy of possibilities, for example in the analysis from the Gugenheim building the result using the SS tool, reveals a higher correspondence in the top right part where the one of the important element is located, that element has a presence of a pure rhythm and at the same time reveals a hierarchy, giving the results that were proposed in the beginning, being the rhythm and then hierarchy as a composition syntax result, revealing the order that objects should demonstrate.

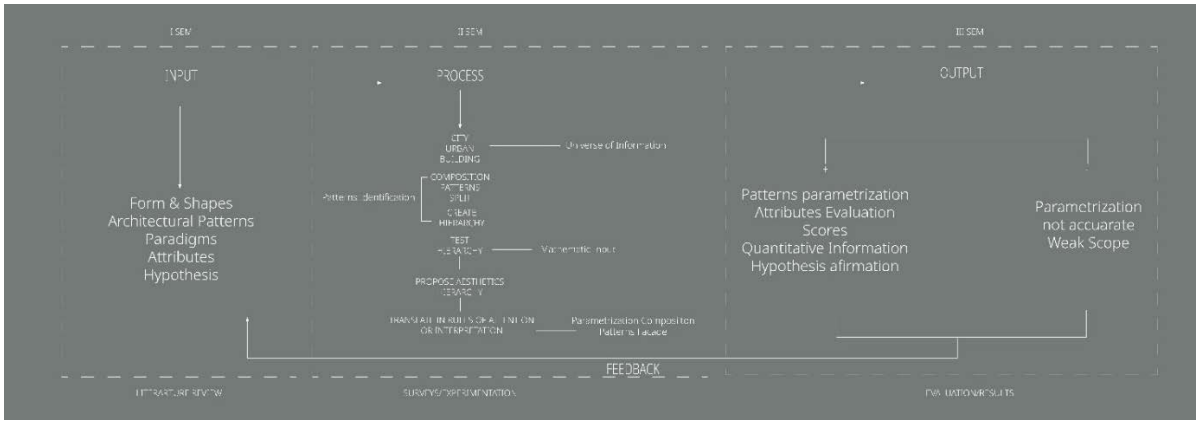


Fig. 67. Hypothetical model by author

3. Experimental application of architectural patterns in a building design

In this chapter it will be the realization of a building design from a specific type considering the necessities from the context in the city of Kaunas city in Lithuania, the design will contemplate the site analysis to select the best plot for the proposal in the city, the following step is a detailed analysis in the site selected summarizing amenities, circulation, cultural heritage environment and other elements that had an influence in the design process. The design strategy it will aligned with the local policies and city master plan, to merge the necessities with the architectonic program and bubbles diagram, besides concept from the design will be generated applying the design guidelines.

The relevance from the chapter is the analysis using an alternative method to analysis the context in order to extract valuable data to use in the design phase, creating different alternatives for later be tested to observe the similarities and differences to conclude in the conceptual model changes.

3.1. Location context for site selection in Kaunas City

As it is mentioned before the project will be located in Kaunas City with the objective to provide a deeper understanding of the place where the design proposal could be settled. The places were aligned to the design scope as result from the previous survey to match in element and characteristics from those examples.

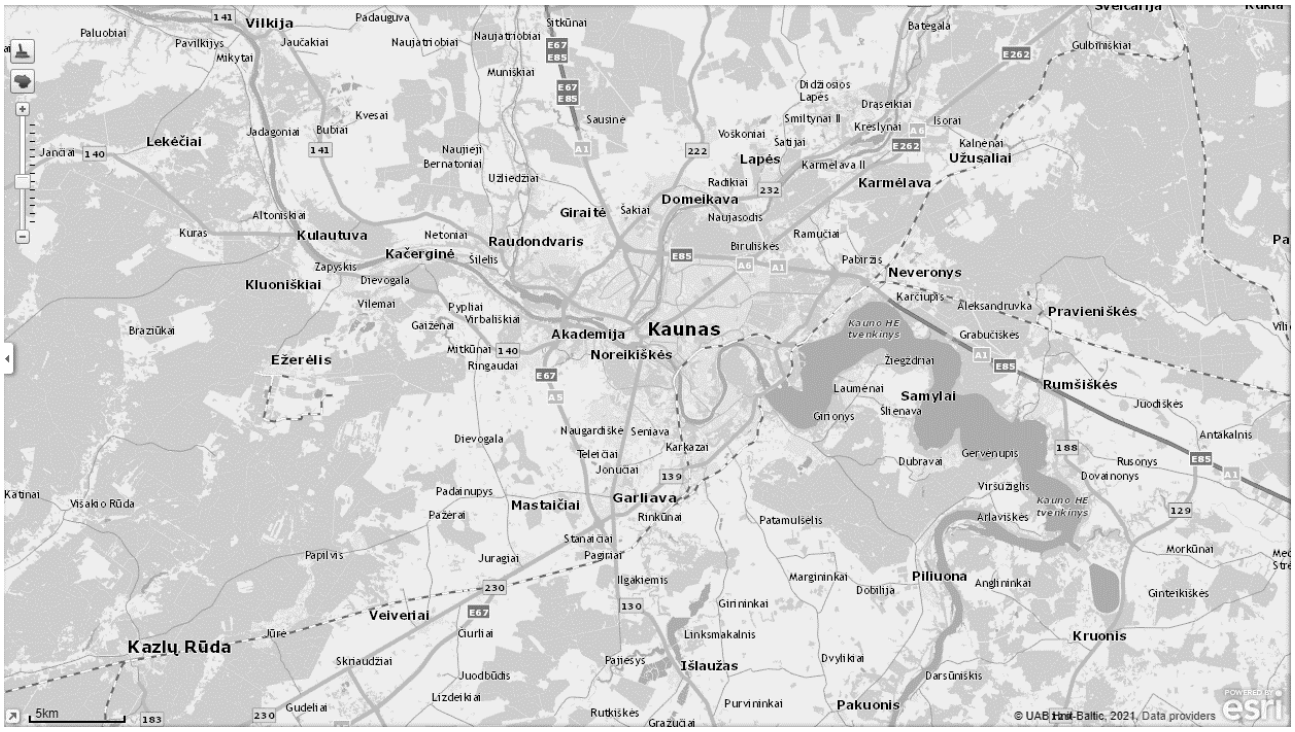


Fig. 68. Kaunas city map (HNIT-BALTIC, 2021)

List of general data from Kaunas City (2016, 2020)

- City area in 2020: 157 km^2
- Level above sea level: 48m
- City population in 2020 (Portal, 2020): 289, 364 habitants
- Density of habitants: 1,843.1 hab / km^2
- Parks: 8,329/15,700 Hectares are for Parklands.
- Humid Continental Climate

To provide a better asset for the evaluation it was started from a macro analysis of the Kaunas City center which consisted of the following:

a. Visual frame: Topography
b. Viability: Interconnection, vehicular and pedestrian access.
c. Flexibility: Restrictions.
d. Upcoming projects
e. Remarkable Places: Heritage and protected buildings.
f. Noise

These criteria guided the site selection, because, by observing the topography of the area, it was looked for the best visual frame. Analyzing the viability of the area, showed the relevance from the city interconnections, and the type of access of them. In addition, the flexibility of the area, the projects in construction and the protected places provided vital information.

During the last survey in chapter 2, a series of different building images with a variety in elements and characteristics were selected and was shown to the focus group to rank according to their insights how valuable they thought the building was in terms of aesthetics attraction. As a result, the most selected picture of each paradigm was taken into consideration due its influence; from which it was noticed that the three most selected choices were public buildings and interestingly museums.

From that insight a functional tree was elaborated with the characteristics of each of the examples selected. This functional tree was meant to guide into a direction to select the type of building design. From the examples, it was noted buildings of private character and buildings of public characters. Those of private character were of two types, residential which was divided into single house residential or multifamily residential; and, industrial type, from which the criteria belonged to a laboratory. In respect to the buildings with public character, there were two types, public building with religious character, from which the criteria were from a temple or a church; and public building with civic character, from which in the example were museums. After the survey was conducted, it was possible to see a pattern; this is because the three results were museums that belonged to the civic type of building and all with public building character. This directed the building type into a specific direction.

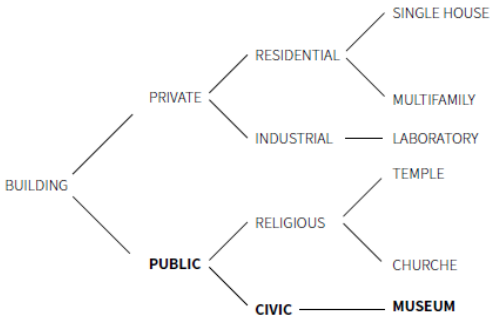


Fig. 69. Functional tree by author

To select the site for the design, three spatial criteria were considering that this method was used to measure the façade CAD analysis:

a. The Visual Frame: In this criterion it was analyzed two different types, the visual frame as an object, for which it was considered the type of view it would have from the building itself; for this, it was considered spaces that would provide a broader view and spaces that providing more attractive sight view from the building. And the visual frame as an overall, this is from the citizen perspective; for this it was observed and chosen points around the city where the building would be more noticeable and appreciated by the people considering the visual range of a person perspective (LaValle, 2021).

b. The Height: Regarding this criterion, it was taken in consideration the different possible elevations that the building could give, for being easily appreciated by the people, at short and long distance. It was decided to not go for a tall design as it would not be well appreciated at short distance.

c. Open Space: It was observed different points and accounted the amount of available space it would have in its surrounding which allow for a better vision to the building. This last criterion contributes to a better visual frame.

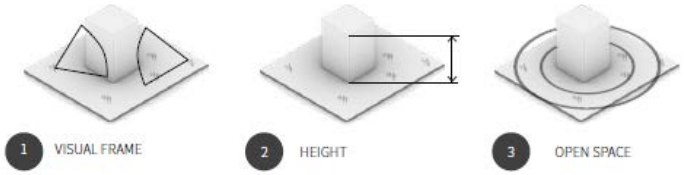


Fig. 70. Spatial analysis criteria by author

After further analysis it was evaluated three zones that could potentially become the site for the design, these being:

a. Old town
b. Akropolis
c. Soboras

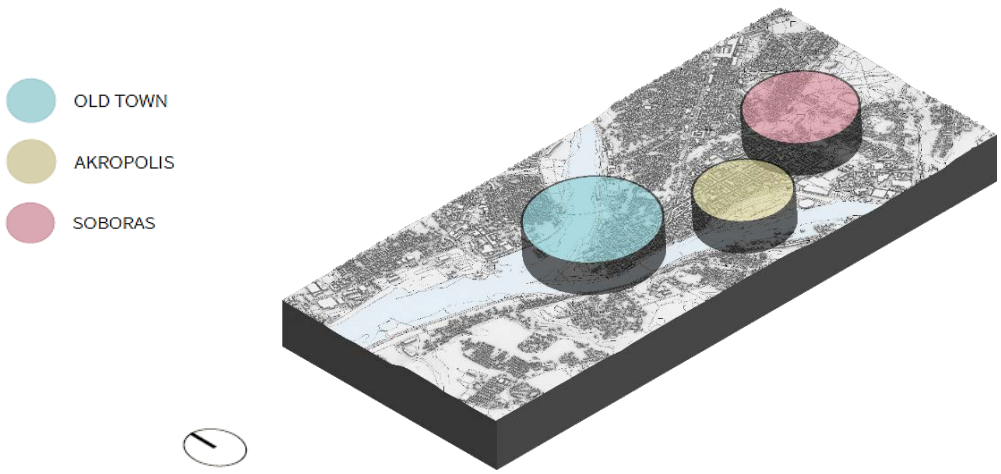


Fig. 71. First selected zones in the crop area of Kaunas City center by author

In the zone of the Old Town, it was considered as advantage the presence of uniformity in the buildings, there is no high contrast in the architecture styles, but instead a lot of similarities regarding the facades and the surrounding projects. It was also noticed a high percentage of pedestrian traffic, indicating that there is many people coming and going on foot to and from in this zone. In addition, Old Town is a compact area, where buildings are no scattered, this comes as advantage as it would allow that the building connectivity to the surrounding places and not to be disperse.

In disregard of the advantages of Old Town, it was also considered the disadvantages which included the visual boundary, corresponding to the limiting factors such as style, which specifies that a proposal should remain within similarities in design of existing buildings in this case pattern analysis should be conducted to gather importance inputs to continue the building design; and policy statements that limit the maximum elevations for a building in the area (Siemas, 2013). Similarly, the zone contains a high density of population and buildings, turning it into a clustered area hindering the possibility of placing a new proposal. As result of this cluster, it was determined that a possible lack of space is a disadvantage of this zone depending on the availability of empty spaces or spaces to rebuild.

The second zone selected, Akropolis, presented several disadvantages such as noise due to a great amount of vehicular traffic and vast amount of construction sites. Because it is an easily accessible area by vehicle there are road hierarchies which would affect the importance and view of the project. Lastly, the zone of Akropolis is non aesthetic, as it does not provide a visual attraction regarding to its architectural composition from the nearest building.

Besides the disadvantages, it was evaluated that the advantages of the Akropolis zone include a high percentage of nature in its surroundings; also, the zone possesses a high pedestrian traffic, as many people travel through it and visit it. Consequently, there is a new focus on the area due to new projects turning the zone into an attractive point to visit in the future.

Lastly, the third zone, Soboras, provided with a regular and fluid pedestrian traffic as it is one of the most centric places in the city, therefore, it becomes a passage that interconnects main streets and towns, for this reason it is considered an important touristic zone, working as one extreme, the heart of the streets, are they all end in this zone. Nevertheless, although advantages seem attractive, the Soboras has an urban boundary well defined between old town and new town, in which each area is well defined according to architecture and planning, complicating making a new proposal. Moreover, the zone is considered a heritage place due to several protected places that cluster the zone. The cluster of these heritage places contributes to the lack of space for new projects.

These disadvantages and advantages are summarized in the following table

Table 16. Summary of site selection factors by author

Zones	Advantages	Disadvantages
Old Town	Uniformity	Visual Boundary
	Pedestrian Traffic	High Density
	Compact	Lack of Space
Akropolis	New Focus	Roads Hierarchy
	Nature	Noisy
	Pedestrian Traffic	Non-Aesthetic
Soboras	One Extreme	Urban Boundary
	Pedestrian Traffic	Heritage Space
	Connectivity	Lack of Space

Subsequently to the zone selections for possible sites, it was established from the fundamental tree based on figure 69 in which it was concluded for a design of public and civic character, in conclusion the design should be aligned with a museum typology. But, for better knowledge on the need of the area it was evaluated the qualitative and quantitative information on existent museums in the selected zones. The results from the observation demonstrated a high density in the number of museums and a great concentration in variety of new projects of the same character (administration, 2020).

As a result, it was decided to consider a new criterion, in which it was proposed that the design could also serve an educational purpose beyond a museum; for this, it was divided into two possibilities, a school or a library, from which it was concluded to promote a library space or reading area. And based on this it was made a similar research on libraries as it was conducted for museums. The results from this new search demonstrated a lower density in number of libraries existent in the zones, allowing them to be spread around the area; as well, they seemed to provide mix uses, making place for a new proposal with broader functionality; the variability in the height of these buildings granted the possibility to consider different height options to include in the design.

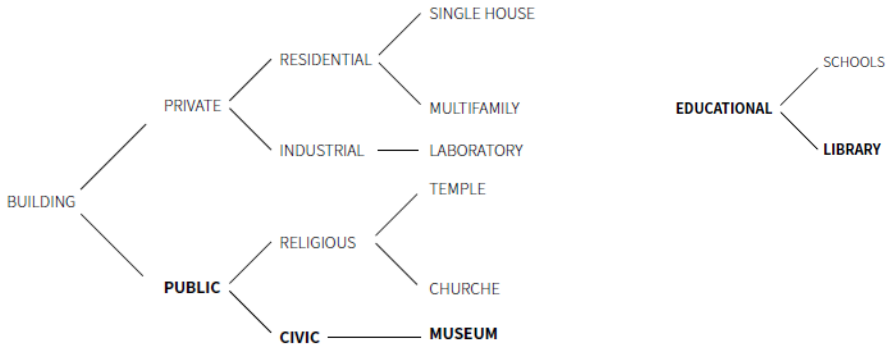


Fig. 72. Modified functional tree by author

Museums

In the research of existent museums in the selected zones it was obtained a total of 25 museums in use, from which 2 of them were private and 23 of public use. With this count it was determined that there is:

- High density of museums
- High concentration of museums in the the zones
- Variety in types of museums
- Large number of upcoming projects

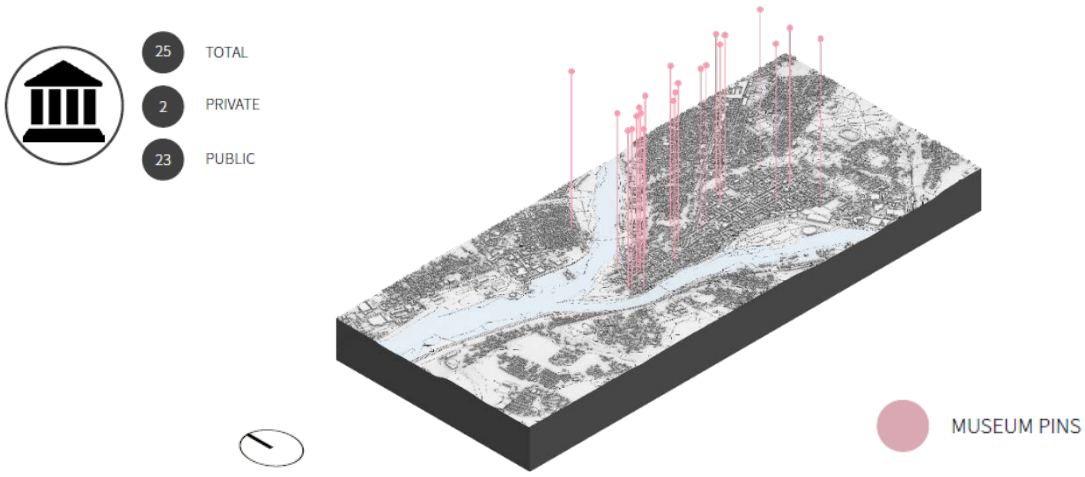


Fig. 73. Museums around selected zone by author

Libraries

Once done with the search of existent libraries in the zones selected it was obtained a total of 14 libraries from which were classified into big (2), medium (7), and small (6) sizes. With this it was determined the following:

- Mix uses for the libraries
- Height opportunity for upcoming projects
- Libraries are largely spread between one another

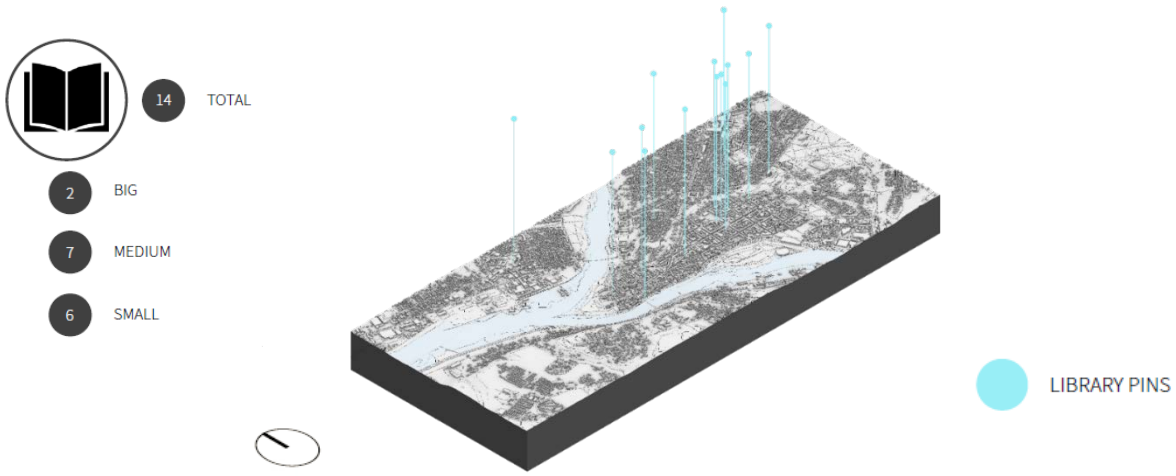


Fig. 74. Libraries around selected zone by author

In addition to the analysis of the selected zones it was researched about the viability to these zones. As result, it was obtained that the most relevant streets are the following:

- Laisves al. & Vilnius G.
- Savanoriu Pr.
- Uznemunes G. & H. IR. O. Minkovskiu G.
- Karalius Mindaugo Pr.
- Petras Vileisis Bridge.

These streets are considered relevant because they interconnect the center of the city with the rest of the surrounding areas of the city, conveying in the core of New Town, influencing the increment in the vehicular and pedestrian traffic towards the selected zones (sąrašas, 2018).

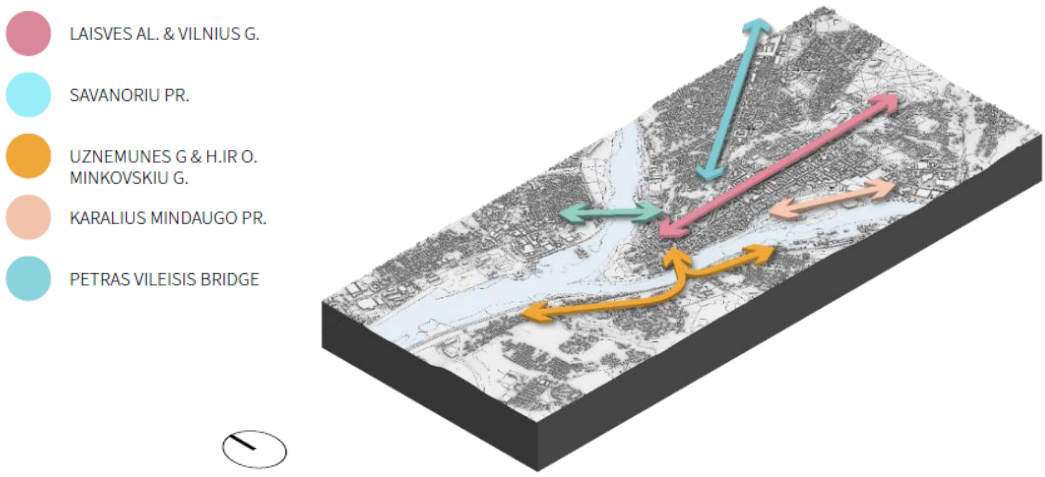


Fig. 75. Main roads Kaunas City by author

An important relevant aspect to be considered are the points of attraction in the selected zones that can influence over the proposal. These points of attraction are the following:

a. Kaunas Castle (Museum): Located at the confluence of the Nemunas and Neris rivers was built in the 14th century to defend against the onslaught of crusaders. Considered one of the first castles in Lithuania, it has now turned into a Kaunas City Museum Branch and annual cultural events are held in and around it. Santaka Park next to this castle is called the heart of Kaunas (In, 2021).

b. Town Hall (Museum): The most important building in the Town Hall Square. Filled with a gothic, baroque, and early classicist spirit, it is often referred to as the White Swam because of shape and color. Its purpose has changed over time being a place where city's markets, fairs, and trials took place. Currently, it holds ceremonies and official events (In, 2021).

c. Soboras (Church): A neo-byzantine-style building, placed in the eastern part Laisves Aleja, constructed for the Kaunas fortress garrison, as a representational structure, expressing luxury and official status. Recently it operates and holds church music concerts, performances by actors, and exhibitions are continually on display (In, 2021).

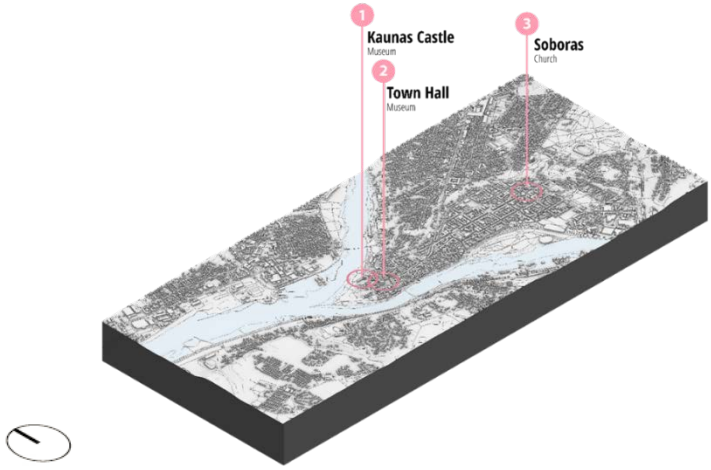


Fig. 76. Iconic elements in Kaunas city by author

Due to the increment in developments taking place in the peripheric area of the selected zones, it is crucial to analyze them to have a better projection on how the inner density of the city changes by the increasing urban condensation of the city as result of new upcoming projects. These projects are divided into two categories, the new infrastructures, and new buildings (In, 2021).

a. New Infrastructures**:** Kedainiai Bridge and Nemunas Bridge.

b. New Buildings: Ciurlionis Concert Center (Auditorium), Science Island (Science Center), and Water Sports (Sport Facility).

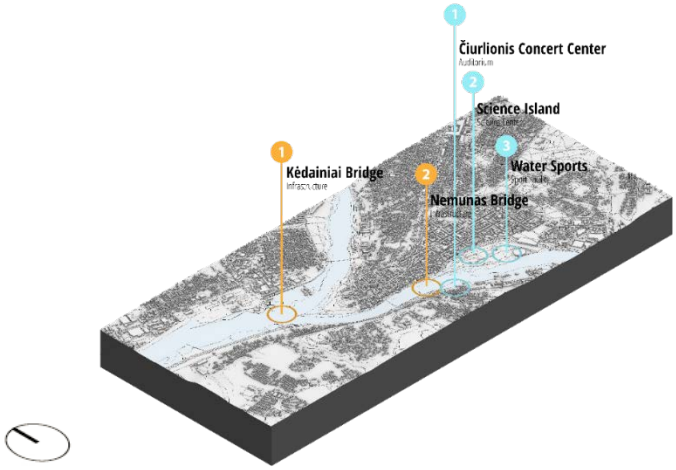


Fig. 77. Upcoming projects around selected zone by author

A great influence on the project is the visibility of it, which is critical on how the citizens evaluate the project by their perception of it from different zones. For this approach, it was decided to establish the most relevant visual frames, these being:

a. High point of view in the visual frame by the pink color.
b. Medium point of view in the visual frame in light blue color.
c. Low point of view in the visual frame in yellow color (from the river).

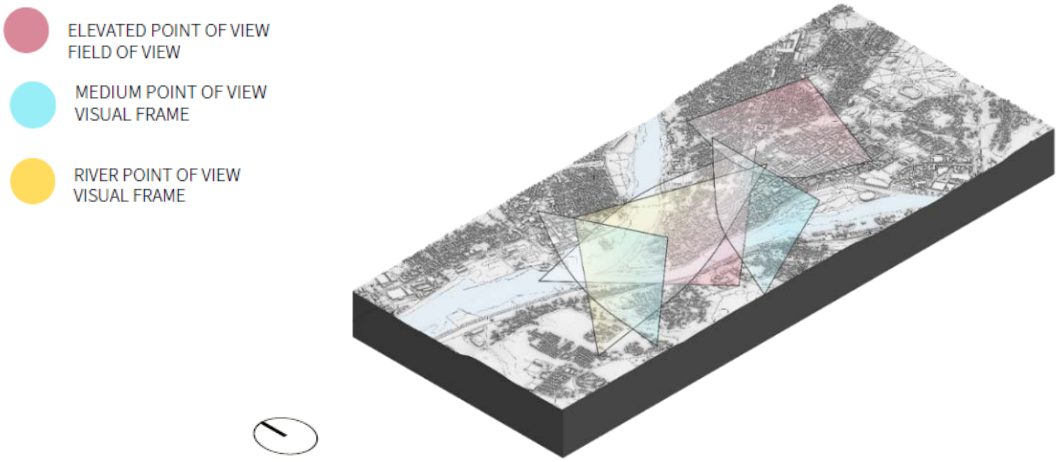


Fig. 78. Mixed visual frames by author

Consequently, from the analysis of the visual range, it was noticed that there was a convergence of all visual frames towards the center of the city, and a few surrounding areas. Utilizing the results of this analysis in addition to the investigation done on the selected zones, it was proposed four sites that were thought to be most relevant for the project. These sites were the following:

a. Brastos Gatve
b. Old Town
c. Zalgaris Arenas
d. Kauno Biblioteka

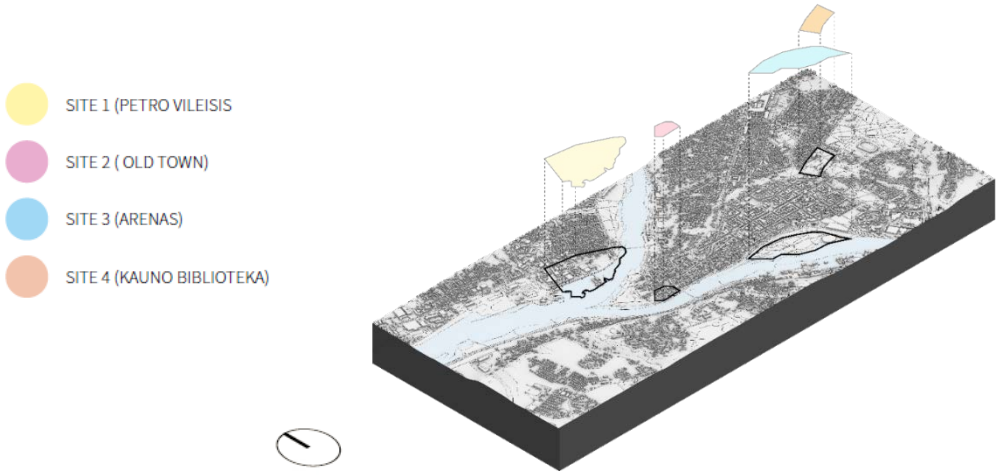


Fig. 79. Site proposal selection by author

For the site proposal it was necessary to dive deeper into three main aspects, these being, the legal aspect that encompasses the different uses or purposes given to the lands use, the physical aspects which refers to the topography of the land providing an understanding of the altitude at which the land is located, and, the environmental aspect, which refers to the noise level surrounding the site. Based on the result of these three approaches it was decided to choose for the site that allow to build accordingly to the flexibility in terms of use and purpose, with better altitude convenience and less noise.

3.1.1. Land use from the selected zones under the law of Kaunas City

For having a better site understanding it was researched further into the different uses that were given to the lands, with this it was able to consider the sites where the building would fit better into the existing uses or to provide a new use to the site (PLANAS, 2020):

a. Brastos G.: This functional area works as a residential zone of high intensity. It is a territory dominated by multi-apartment residential construction together with the necessary social, commercial, and service infrastructures.

b. Old Town: This zone is a city center territory, which has special requirements for the protection of cultural heritage, public spaces, and architectural quality of buildings. The land is used for residential, social, management, administrative and commercial activities. Other uses of this land include areas for engineering infrastructure and recreational green areas.

c. Zalgaris Arenas: Used mainly as a public travel area; is also intended for public needs such as social activities, service activities (e.g., trades, exhibitions, tourism, etc.) and has commercial purposes.

d. Kaunos Biblioteka: Greenery and town squares are used intensively for visiting. The main uses are for active recreational spaces.

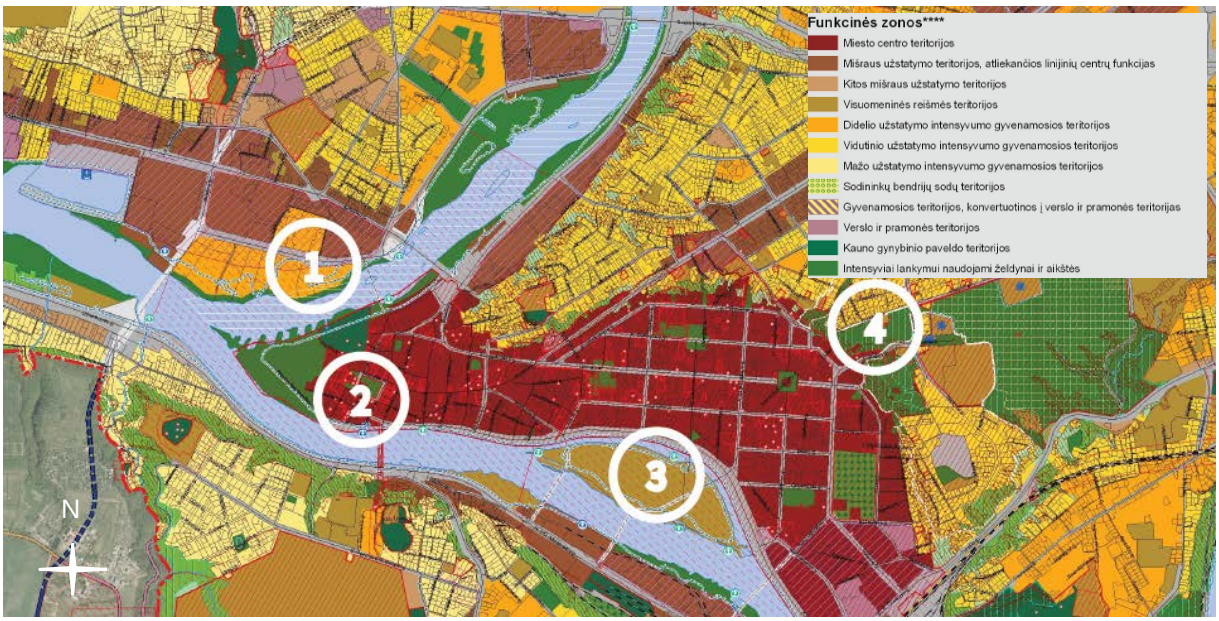


Fig. 80. Local policies of the selected site proposals (PLANAS, 2020)

3.1.2. Physical features of site selection in Kaunas City

The physical environment is a fundamental analysis in the site selection, as it will mention the one site that has an influence in the selection criteria:

i. Topography

After inquiring about the uses of the sites, it was analyzed the forms and features of the land surfaces from the proposed sites. From this, it was mainly focused on their respective altitudes. As result, it was determined that the first three sites (Brastos Gt., Old Town and Zalgaris Arenas) are found at the lowest points around 82-105ft, leaving them at a considered risk if the river when increase its level; while the last site (Kauno Biblioteka) is found at a higher altitude, around 276ft.

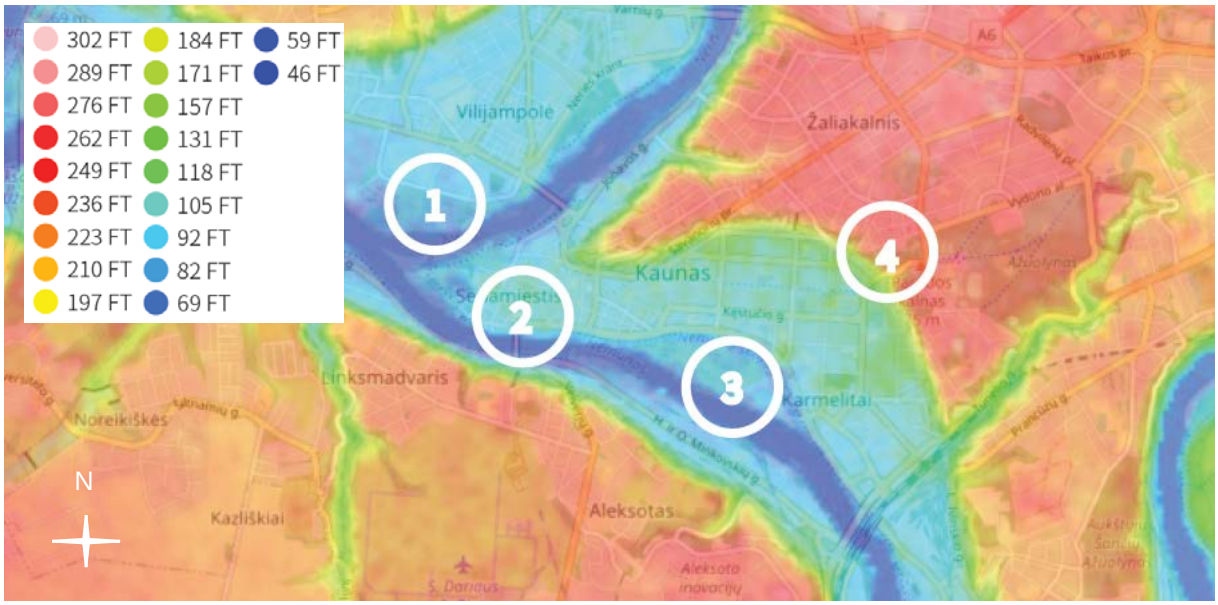


Fig. 81. Topography near to site proposals by author

ii. Noise

Another aspect observed and studied regarding to the sites was the environmental aspect, in which it was identified the volume of noise present in the area (infr.kaunas.lt, 2020). From the results, it was able to conclude that the noise around the sites is high in decibels; although among the sites it seems to have no difference, it was considered it to be an issue that should be addressed through the design. The level of noise identified around the sites proposals are from lowest 50-54 DB and highest about 65-69 DB.

Fig. 82. Noise affectations around site proposals by author

3.1.3. Site selection for the development of design proposal

To choose the definite site for the design proposal, it was made a graph of matrices. In the matrix each aspect was organized to evaluate such as design, interconnection to other areas, physical and visual impact; after this, it was measured from 1 to 5, this last being the highest score to evaluate each aspect. According to the aspects and the results it was chosen a definite site, which was Old Town.

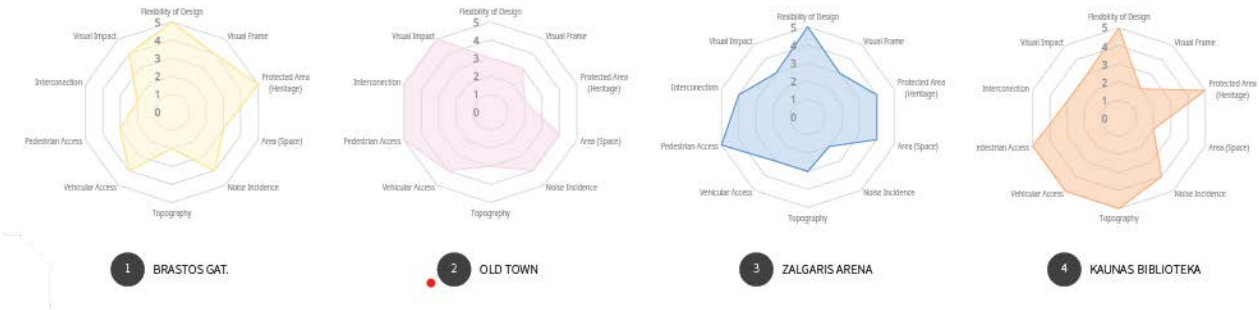


Fig. 83. Site matrix selection by author

Once having selected the definitive place for the design proposal, it was conducted a generalized analysis of the site, and after collecting the information, a specific researched was made. Both analyses were done within a radius of 1 km^2. For the general analysis, it was collected information that would help to understand the demographic organization of the zone and the space encompassed within.

Further into the specifics, it was analyzed the viability of the site, to have knowledge on the most relevant streets that go into and out of the site. As well, it was researched on the amenities present in the area, which included the gastronomy, hostelry, commercial and educational places; this allowed to understand the flow of activities, level of attraction to the place, and tourism perspective. In like manner, it was analyzed the heritage places, and the types of renovations present in the zone near to the site proposal; the knowledge on the protected places let to understand the architectural value of the area and the significance it has for the city. Lastly, it was considered the climate of the site. Having all these aspects acknowledged it was permitted to stablish a design approach for the project.

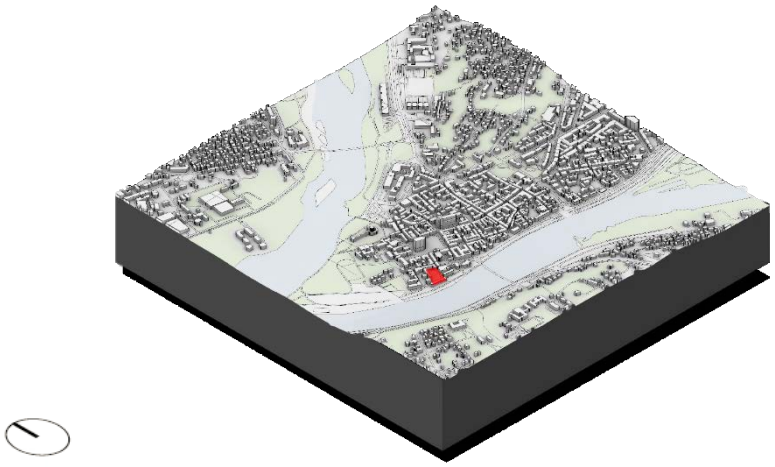


Fig. 84. Section from selected site (Old Town) with remark of the chosen plot by author

In the area of the Old Town (en.kaunas.lt, 2020) there is a density of 3215 habitants per squared kilometer (h/km^2), and it was estimated that there are about 3000 habitants approximately within the 1 km radius in the area selected. Inside of this radius there is a convergence of 5 areas, a portion of New Town, Old Town, and both crossing sides of the river.

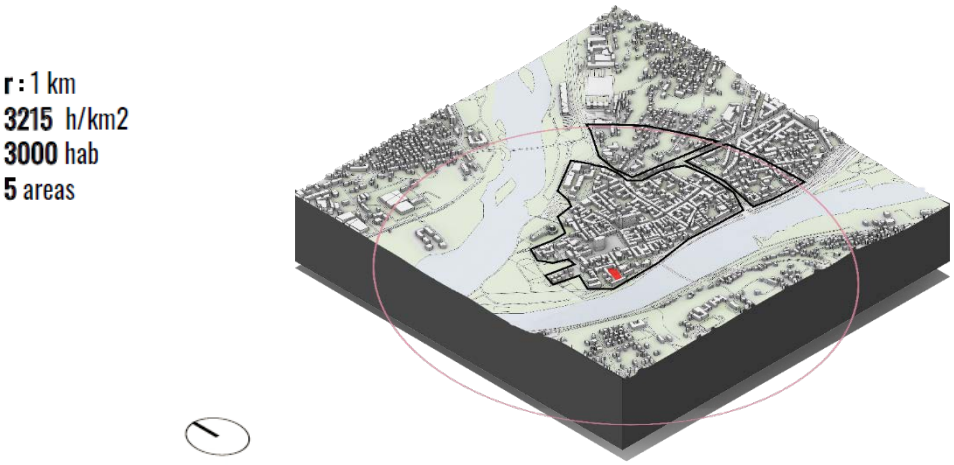


Fig. 85. Image of 1 km radius from selected site by author

3.1.4. Circulation and roads in old town site selected

Once stablishing general information about the site, it was important for the analysis its viability; for this, it was searched about the traffic, avenues, and streets that were of major influence on the site. As result, it was obtained the streets that contain most of the vehicular traffic, which were categorized into high traffic, that includes Prospectus & Gatve, with approximately 25-15 meters in width, and medium traffic, including Gatves with about 12 meters.

In addition, it was gathered the relevant streets that contain most pedestrian activity, for this, it was divided into the pedestrian old town, which include Aleja & Gatves with about 25-10 meters width, and pedestrian riverside which includes both sides of the river with approximately 3 meters width. Finally, it was identified key sidewalks of less size that are of great importance; these sidewalks are longitudinal and transverse streets within the Old Town. The longitudinal streets (Gatves) are of approximately 7-5 meters in width, while the transverse streets (Gatves) are about 7-4 meters.

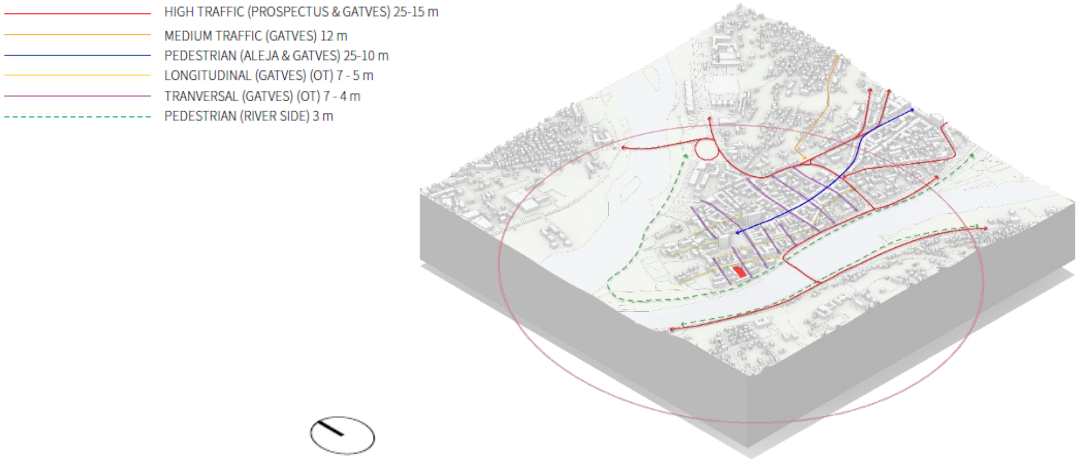


Fig. 86. Flow of viability in within the area by author

3.1.5. Site amenities and other commercial spaces in old town site selected

A big influence on the site are the nearby amenities present in the area, therefore, it was decided to identify the quantity and proximity of these to the site. The amenities chosen for this analysis included food premises such as restaurants, cafes, bars, pubs, and similar places related to gastronomy; hotels and the likes; business places; and educational institutions. In overall, it was identified 166 amenities within 1 km radius from the site. A great concentration of these amenities in the Old Town, generates great points of attraction.

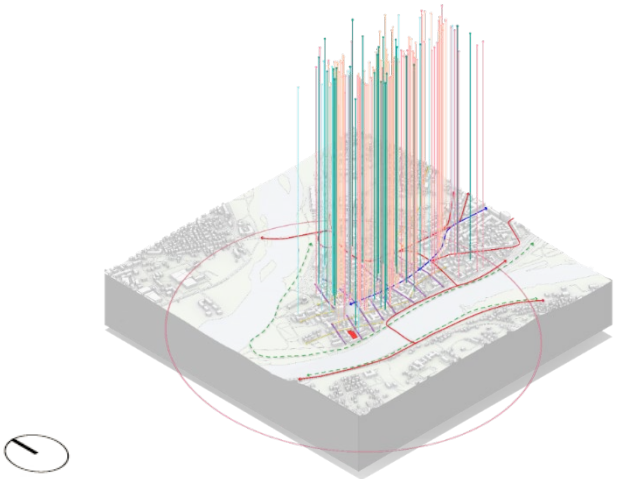


Fig. 87. Amenities located within the 1 km radius by author

i. Gastronomy places

From the 166 amenities identified, 60 of them belonged to gastronomical premises. These premises included restaurants, coffee shops, pubs, and other related places. It was highly noticed that the concentration of these premises was high along the widest pedestrian streets, and those with access to the central part of the zone.

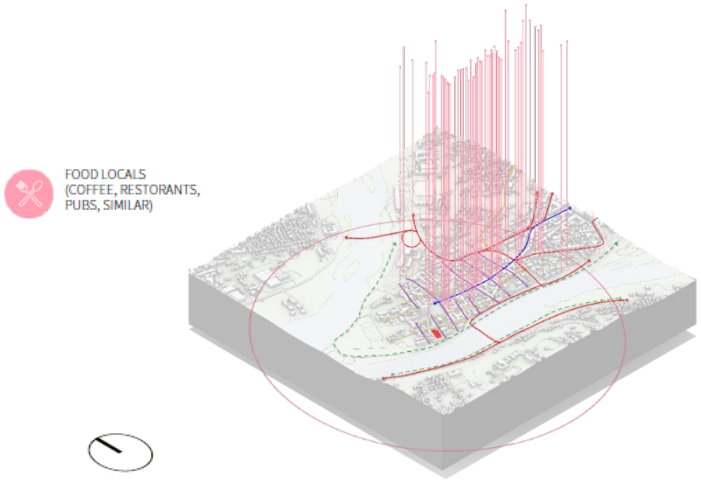


Fig. 88. Gastronomical premises counting by author

ii. Hotels and lodging

The quantity on hotels present within the 1 km radius was less in comparison to the quantity of gastronomical places. Out of 166 amenities, only 14 were hotels and similar. In contrast to the restaurants and cafes, the hotels are not as concentrated, but rather scarce through the area. Most of these hotels are well known and constantly occupied, for example, The Best Western Santako Hotel, The Amberton Cozy Hotel located right next to the Town Hall at confluence of the river Nemunas and Neris, The L'artisan a hotel restaurant which provides a panoramic view of the Old Town, and the 4-star Daugirdas Old City Hotel located in the heart of Old Town, 50 meters from the Old Town Square and occupies a restored building from the 16th century.

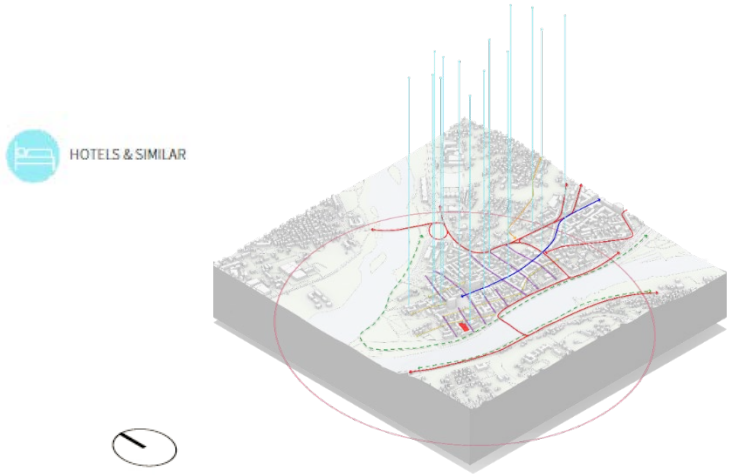


Fig. 89. Hotels within the 1km radius from the site by author

iii. Commercial

Most of the percentage of the identified amenities belonged to commercial or business premises with almost a 40% of them, this is because, out of 166, 65 were business infrastructures. After analyzing their locations, it was noticeable that they are concentrated towards the center of the zone, aligning in sequence along both sides of the pedestrian Old Town, but, at the same time they are being accessible through the transversal streets and longitudinal streets of Old Town.

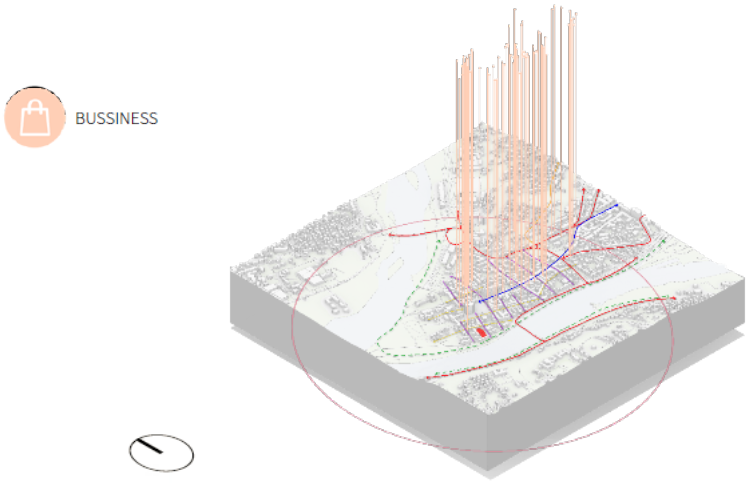


Fig. 90. Business premises within the 1km radius from the site by author.

iv. Education

The last amenities that were looked at were the educational institutions. A total of 27 educational premises were identified, of which included museum such as Maironis Lithuanian Literature Museum and universities such as Kolping University of Applied Science, which also serves as a space for seminars and conferences, and The Vytautas Magnus University Art Gallery “101” which act as a forum where diverse audiences can participate in cultural experiences. From the identified institutions, it was noticed that the major concentration was found along the Pedestrian Old Town, or towards the center of Old Town, while others are scattered around the area,

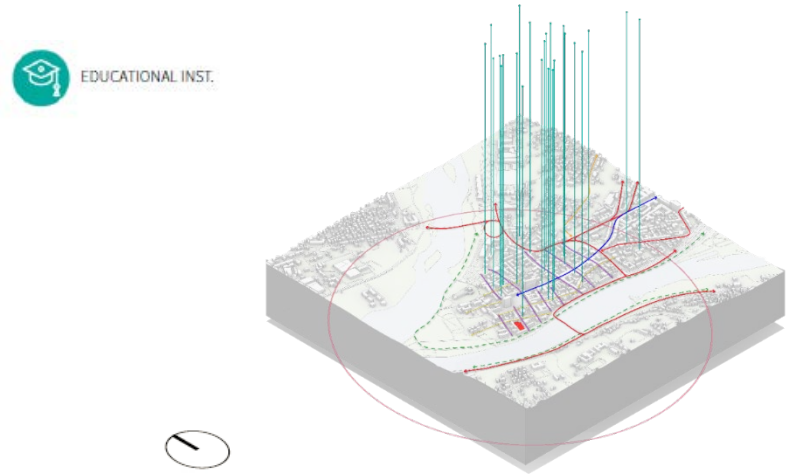


Fig. 91. Educational institutions located within the 1 km selected area. Author.

3.1.6. Cultural and heritage locations in old town site selected

The evaluation of importance and level of attraction belonging to the Old Town (departamentas, 2020), guided to identify the heritage protected buildings existent in the zone. Due to this, after researching it was obtained that in a radius of 1 km from the site, there are a total of 7 main protected places, out of which 4 are religious infrastructures, 1 of commercial manner and about 2 public historic buildings (1 museum).

The heritage places identified within the radius were:

a. Kaunas Castle: Nowadays serving as a museum branch, annually gives place for cultural events that are held in and around it (In, 2021).

b. Bernardine Church: Once being the largest church in Kaunas, it was constructed between the 15-16th century. The church was destroyed during the war with Russia in the middle of the 17th century, but, by the second half of the 17th century the magnificent baroque interior was restored which has survived until nowadays with minor changes. The church was closed in Soviet times in 1950 and was used as a medication warehouse. In 1993 the church and its monastery were returned to the Franciscan Orde (departamentas, 2020)r.

c. Kaunas Town Hall: Constructed from 1542, often referred as the white swan, because of its shape and color. It is a 53-meter-high tower; therefore, it is considered the tallest in the Old Town (departamentas, 2020).

d. Jesuit Church of St. Francis Xavier: Building with a late baroque architecture, with two towers rising towards the sky is located near the Town hall. Famous for having Adomas Mickevicius and Jonas maciulis-Maironis preached their sermons there (administration, 2020).

e. Kauno Sv. Apastulu: A catholic church, one of the first and oldest brick buildings in Kaunas. Next to this main is the parish church of the city, located in the middle forming a regular rectangular square with the Town Hall in the center (departamentas, 2020).

f. Thunder House: One of the most original and impressive residential houses of gothic style in Lithuania, with the original eastern façade. Considered to have been built in the late 15th century. It is famous by the stories about Hansa community, the statue of God Perkunas (Thunder) found in the wall of the building. The building is symbolically associated with Hansa merchants; therefore, it is one of the most popular places during Hansa celebrations (departamentas, 2020).

g. Church of Vytautas the great: The oldest church in Kaunas, built in 1400. It is the only gothic-style church with a cross-shaped plan in Lithuania. The waterfront at the Vytautas church was equipped with a marina so that sailboats could moor, and later steamers (departamentas, 2020).

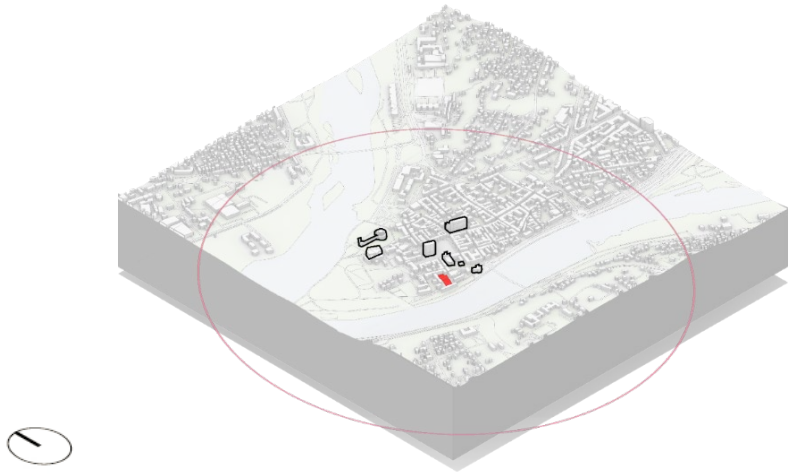


Fig. 92. Heritage places from site plot in the Old Town by author

ii. Heritage neighboring places to old town site selected

Once it was identified the heritage places around the area from the site at a 1 km radius, it was identified it the heritage places around the main site (the selected plot), and, after further research it was obtained buildings in terms of period: from the 15th century, 18th century and 19th century with a high historical value. These places were the following:

a. A regional warehouse complex from 1854.
b. A single national object from 1500, considered a church and monument.
c. A single local object from 1854, a housing.
d. Two single local objects from 1800, housings.
e. A national monastery complex from 1500, known as housing and monument.
f. A regional single object from 1900, a housing.
g. A national single object from 1500, named a church and monument.
h. A state protected basement complex, a cellar.

Building complexes relate with the research in order to understand the components that condition the disposition on the space, but moreover of the occupancy of the space is the logic of how these social elements are shaping the settlement of this type of building or entity. From the building complexes it was observed in the building properties, which in the beginning it was concluded that the connection with the environment leads to understand the main building, as a result the roof can be an important element in the building representing the social behavior of the people inhabiting the space.

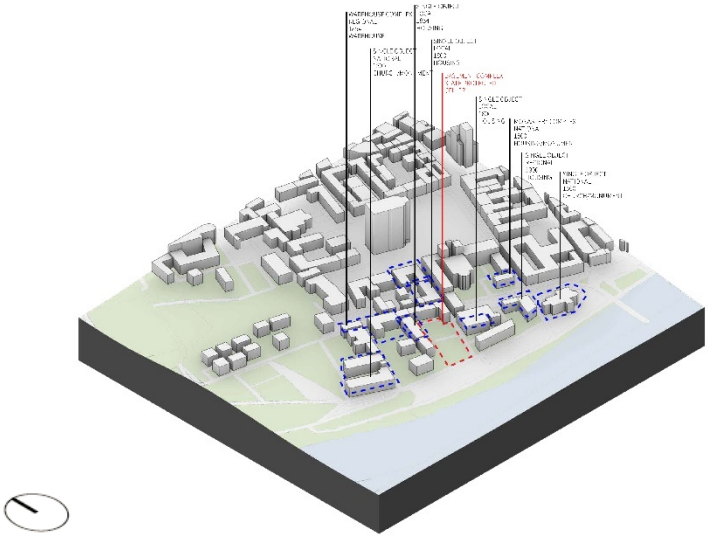


Fig. 93. Heritage places from nearby areas from the site by author

iii. Renovation approach of nearest buildings

After finding the different heritage places of the site, it was necessary to consider the possible renovations that had been done to these buildings and determine the type of renovation they had undergone. For this purpose, it was selected three of the buildings that had gone through this process. After the selection, it was compared through images and research before and after renovation to determine whether the building have a similarity, contrasting, or neutral approach image regarding to its previous look (Spurr, 2012). As result, it was noticed that one of the buildings was neutral in respect to its previous look, neither contrasting nor as similar as originally; while the other two buildings presented a similarity to the original design, making no contrast to the surrounding looks and more of a remembrance of the past.

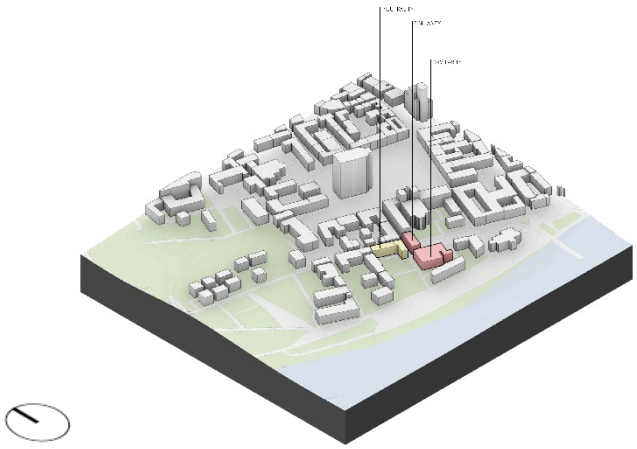


Fig. 94. Renovated buildings near to the site by author

3.1.7. Climate conditions

A particularly important aspect to consider in the site analysis is the weather (meteoblue, 2020). It is relevant to keep in mind that each season last for about 6-7 months. From the month of September, the temperature starts decreasing gradually having as low temperature around 8 degrees and high temperature of 18 degrees, the weather continues decreasing reaching the lowest temperatures by December up to February with temperatures of -5 degrees Celsius and 0 degrees, by the month of March it remains cold but gradually increasing for the next months until reaching the highest temperatures, about 12 degrees the coolest and 23 degrees the hottest. With this It was determined that the cold season starts from September and finalizes in February-March; while the hot season starts by March-April and finalizes by August-September.

In the following figure it is illustrated how is the circulation of wind and the fastest speed it reaches at certain areas of the chosen site:

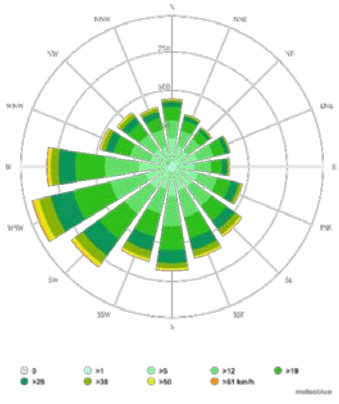


Fig. 95. Wind directions in Kaunas City (Meteoblue, 2020)

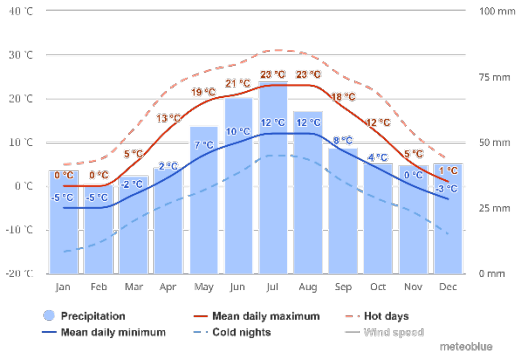


Fig. 96. Average temperatures and precipitation in Kaunas City (Meteoblue, 2020)

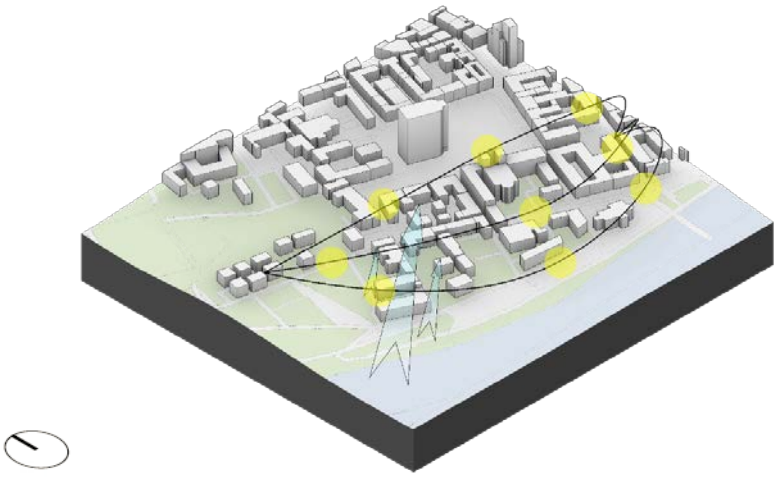


Fig. 97. Sun analysis path near to the site selected by author

3.1.8. Design insights for the design proposal

At the moment of starting to elaborate the design, it was decided to approach it by analyzing the surrounding spaces, before it was overviewed the activities that took place in them, those from the past to the recent days; from this it was obtained that during the interwar period the plot was utilized for walks, talk and leisure; during the soviet time the spaces were in addition utilized for sailings (as ports), feeding animals (by the riverside), or just standing and observing. But, to obtain an answer of the present day it was addressed an observation in detail walking around the zone to observe the activities that people would be doing in these zones.

Through this way, it was observed that people would use the space for long and short talks, walking, leisure times, some of the people would be taking pictures, others eating, it was observed a person or two reading, running, jogging, or exercising. In addition to all these activities, it was noticed that the zones with more sounds or noise, as well as the areas where more fauna is appreciated, and the zones where people use floral decoration in their spaces.

Besides the identified activities it was also observed the materials that had major dominance in the architecture of the place; for example, it was appreciated a dominance of asphalt, concrete, masonry, and tiles. Similarly, it was determined the dominance in color from which it was identified grey tones, orange, brown and blacks.

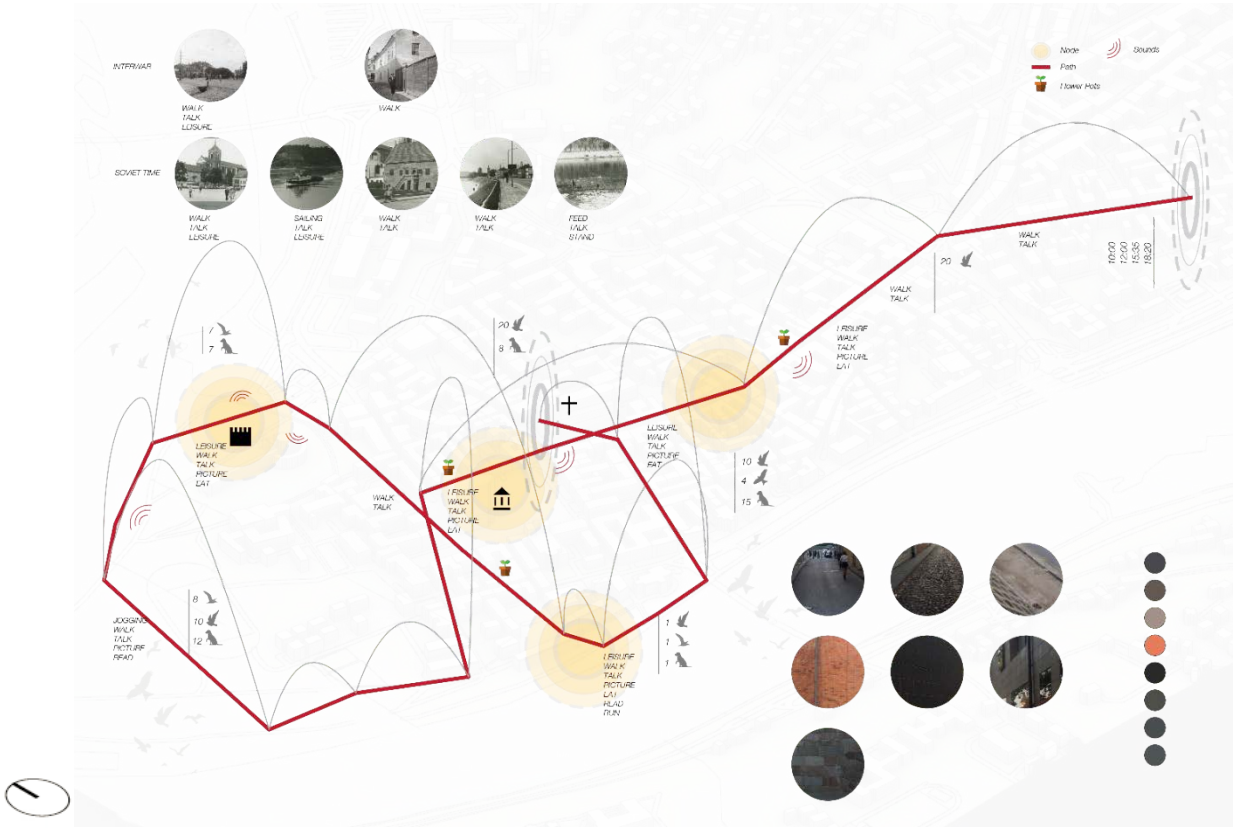


Fig. 98. Derive sensitive study by author

3.2. Project design description and justification

Based on the data collected from previous survey and the analysis, the purpose was to propose a description of what was the purpose from the design proposal; but, to this proposal it was necessary to compare and merge to what the people would want. To know what the people would like, it was prepared an interview with Ms. Ona Peicute, to help to understand the possible challenges, needs and expectations to have from the site. After collected the information, this blended the approach to the new point of view after the interview from Ms. Peicute.

The interview purpose was to collect information that was crucial to achieve a better and more asserted approach for the design. Consequently, at the turn to consult her the following questions were made:

a. What are the challenges with the Old Town?

b. What necessities faces the Old Town?

c. What kind of space is required in the area?

From those questions it was obtained that the challenges with the Old Town are the people and citizens as they change with short periods of time. When it comes to necessities, the Town is in lack of space and consensus. Ms. Ona also commented that the space needs a multicultural space for meetings like Zalgarius Arenas.

After collecting the information new changes were made into the design proposal, from a public building design, it was decided to change it into a semipublic building, as per suggestion, although remaining with educational purpose, to which opted to design an experimental library.

Fig. 99. New functional tree by author

3.2.1. Architectural program

Having the type of building clear it was decided to start defining in depth the division of the areas for every environment area; moreover, in this stage it was created the spatial structure of the design, and this consisted of an entrance space that would connect to a service area around of 215m^2 and to a public space with a total of 2622 m^2, these two spaces would also interconnect with each other; in following manner both areas would reach to the semi-public space separately, this semi-public space has a total of 215 m^2.

The service space can be understood as a zone of maintenance room, for example, an office, storage room or electric room. The public space is often encompassed by zones like libraries (lobbies, group rooms, working zone, etc.), museums (lobby, bathrooms, temporary or permanent exhibitions, etc.), multifunction salons (store, exhibition room, lobby, etc.), terraces, general bathrooms, commercial zones (cafeterias or office supplies), and workshops.

The semi-public space includes start up spaces such as lobby, orientation and pay desk, individual office, team office, conference room, cafeteria, and bathrooms. From all these spaces can be calculated a 25% of circulation space.

Table 17. Architectonic program by author

Type	Zone	Sub Zone	General Zone Area			User Capacity			Area per User			Total Sub Zone Area		
			Capacity (Unit)	Capacity Relationship (m²)	AVG Area (m²)	Max (Unit)	AVG (Unit)	Min (Unit)	Max (m²)	AVG (m²)	Min (m²)	AVG (m²)	Max (m²)	A/SQM
Public	General Lobby		N/A									24		
	Reading room	Looby	30	0.35-0.55 m2	16.5							10		
		Reading Self Service, Reading and Catologue				30				2.3		69	40	
		Subtotal	30								20	**79**	40	**1.3**
	Museum*	Looby	70	N/A								100		
		Orientation &PayDesk				2			10	15	20	15		
		Permanent Exhibitions								2		420		
		Temporary Exhibitions								2		325		
		Open Gallery										249		
		Bathrooms										60		
		Subtotal	70									**1169**		**16.7**
	Conference Salon	Looby	154									12		
		Conference Room				155				1		155		
		Subtotal	154									**167**		**1.1**
	Outodoor Terrace											**880**		
	General Bathroom conference											**15**		
	Commercial	Caffeteria	40									100		
		Book Supplies	10									5		
		Subtotal	50									**105**		
	Workshops	Looby	36			0						3		
		Orientation Desk				1			10	15	20	12	20	
		WS 1				35						113		
		Subtotal	36									**128**		**3.5556**
	General Bathroom for admin and WS											**34**		
	Admin	Looby	3									11		
		General Admin				1			5	7.5	10	5		
		Finance				1			7	9.5	12	7		
		TI				1			8	10.5	13	10		
		Storage room				0			8	10.5	13	12		
		Subtotal	3									**45**		**15.00**
Semi-Public	Start Up Places	Looby	50									25		
		Orientation &PayDesk				1			10	15	20	10		
		Team Office				5				6		100		
		Confrerence Room	6			10				3		31		
		Bathrooms										34		
		Subtotal	56									**200**		**3.57**
Service	Maintenance Room	Office	2			2			10	15	20	30		
		Storage Room	N/A									200		
		HAVC Room	N/A									25		
		Electric Room	N/A									25		
		Pump Room	N/A									25		
		Subtotal										**215**		
Circulation	25%		399									3037		
												759.25		
		Total										**3796**		

For the architectonic program, the factor of user capacity and areas per user was considered based on the standard dimensions and criterion for each area (Neufert, 2000), nevertheless, in some cases it was used the max and minimum index to calculate the average area for each zoning (Julius Panero, 2014).

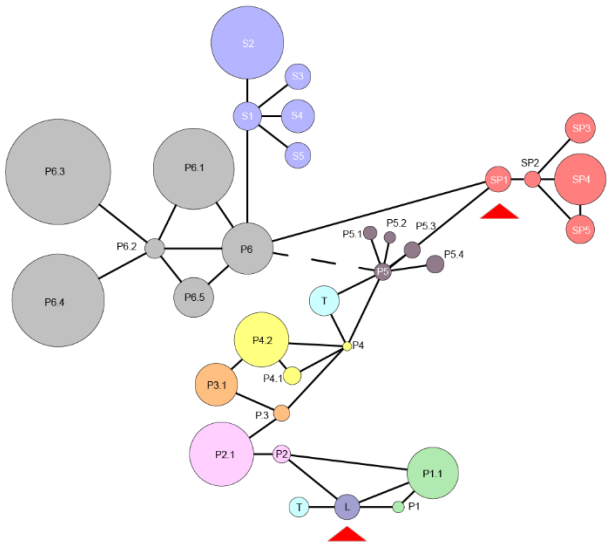
Table 18. Table of area and used of plot area by author

Description	Factor	Area	UM
Plot Area		2122	m²
UI Factor	3.5	7427	m²
Building Area (3 floors)		4028	m²
UI occupancy		54%	m²

From the table 18 the total area considering the 3 floors from the design fulfill the local policies and requirements.

3.2.2. Functional zoning

For the functionality of each zone, it was created the diagrams that would demonstrate the interconnections and hierarchy from the spaces and the representative area of each.



TYPE	CODE	NAME	AREA (m²)
PUBLIC	L	General Lobby	24
	T1	Toilet	15
	T2	Toilet	34
	P1	Book Store	5
	P1.1	Cafeteria	15
	P2	Conference Lobby	12
	P2.1	Conference Salon	155
	P3	Reading Area Lobby	10
	P3.1	Reading Room	69
	P4	Workshop Lobby	3
	P4.1	Orientation Desk	12
	P4.2	Workshop	113
	P5	Administration Lobby	11
	P5.1	Finance	7
	P5.2	General Administration	5
	P5.3	IT	10
	P5.4	Storage Room	12
	P6	Museum Lobby	100
	P6.1	Open Gallery	249
	P6.2	Orientation Desk	15
	P6.3	Permanent Exhibition	420
	P6.4	Temporary Exhibition	325
	P6.5	Toilet	60
SEMI-PUBLIC	SP1	Start Up Lobby	25
	SP2	Orientation Desk	10
	SP3	Toilet	34
	SP4	Team Office	100
	SP5	Conference Room	31
SERVICE	S1	Maintenance Office	30
	S2	Storage Room	200
	S3	Pump Room	25
	S4	HAVC Room	25
	S5	Electric Room	25

Fig. 100. Functional zoning scheme by author.

3.2.3. Volumetric configuration

The volumetric configuration of the design was concluded by calculating the areas and volumes to organize them based on the architectural program. At this stage it was decided to organize the elements in respect of the spaces, for example, they were arranged to set, where to place the stairs, elevators, toilets, offices, service areas, startup spaces, and bookstores.

After considering how each level would be divided and fitting the elements into the spaces, it was found different arrangements to analyze, and, after a couple of designs it was opted for the configuration that allowed the most optimum functionality and flexibility of the space.

3.2.4. General design guidelines for multifunctional building

The concept of the design is based on giving access to people to move freely through the space, meaning that the place should have a pedestrian permeability. For the building elevation it was decided to give the building 3 levels including the underground floor; in terms of the façade, it was considered using the skin element to generate a good reaction from the citizens.

Proposing the creation of a skin that blends smoothly with the surrounding and fits into similarity with the existent buildings. With this, it was intended to enhance the archeology of the place and its function; to achieve this the aim for a radial design and not a linear one, by this it will allow the interconnection to different areas and increment the functionality of the space.

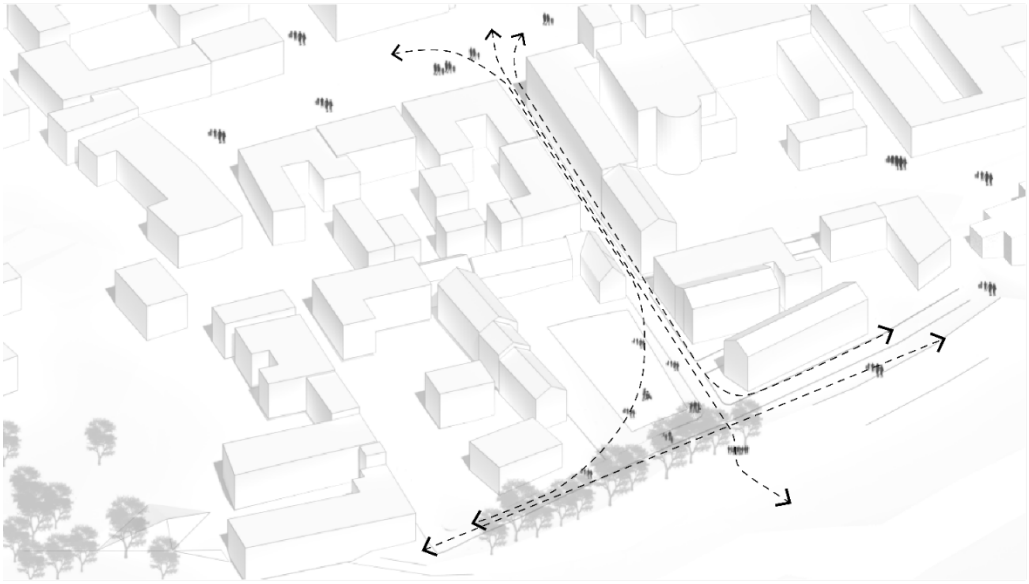


Fig. 101. Projected pedestrian flow by author

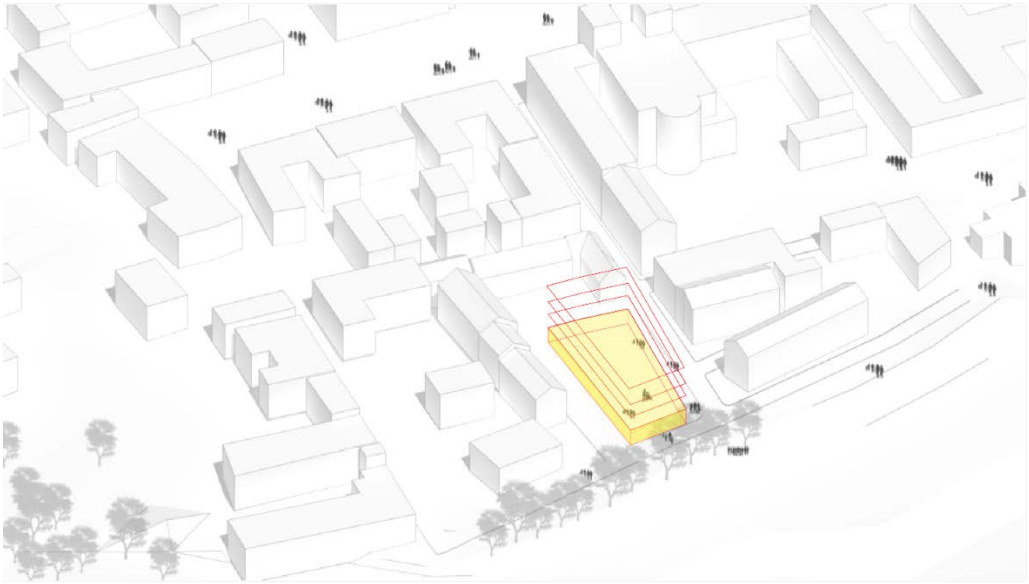


Fig. 102. Projected levels of design proposal by author.

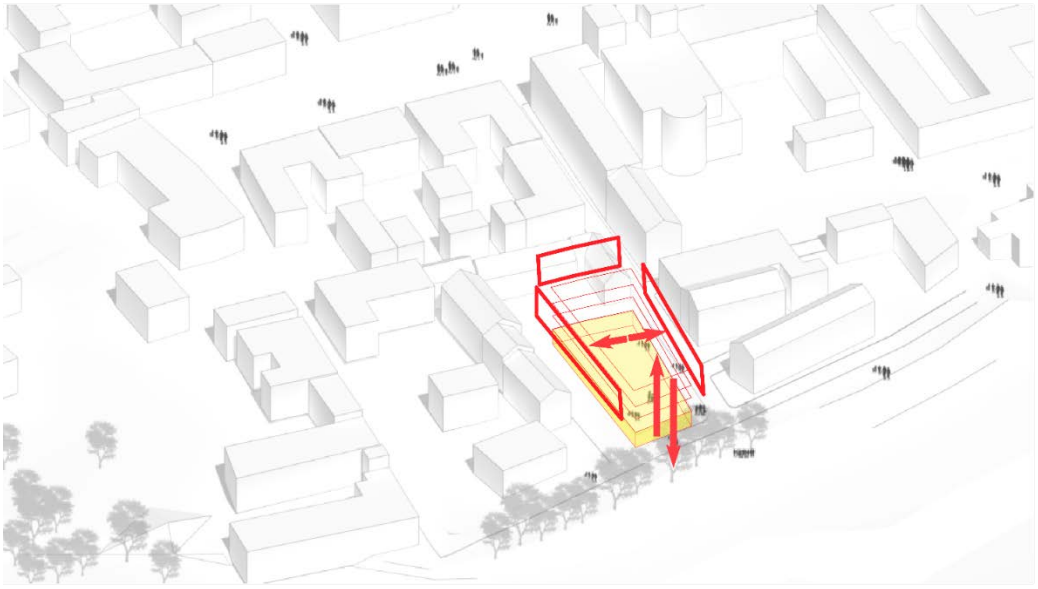


Fig. 103. Projected skin elements consideration and space by author.

At this stage it was defined some guidelines to generate the design, and to properly apply a pattern analysis of nearby buildings, as well the pattern analysis from previous studies and for the script of cluster points (visual codes). These guidelines were the following:

a. Elaborate a design that creates a contrast but at the same time integrates in the environment.
b. Create a design that works as gate, that interconnects to different areas to allow proper access.
c. Make a design to promote a space for the people, for the citizens to have a pedestrian right.
d. Allow a design that brings remembrance to the people.
e. Design a building flexible enough to be able to use the space for different purposes.
f. Generate a design that is self-sustainable in its modum operandum.
g. Produce a design that complements the environment.
h. Originate a design that promotes a more versatile urban environment and brings new elements to the space.

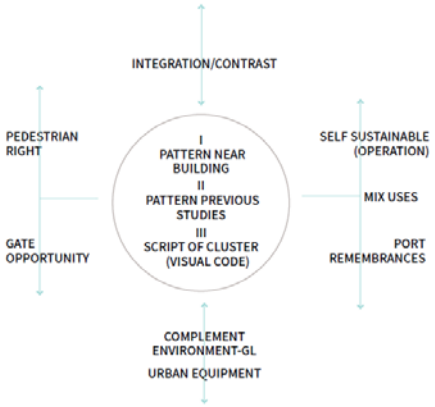


Fig. 104. General guidelines for multifunctional building by author

3.3. Patterns parametrization from façade analysis

To obtain quantitative data for the design proposal, it was applied a façade analysis of nearby buildings with the help of different Computer Aided Design (CAD) programs to obtain quantitative elements that would contribute to the pattern parametrization in the application of the design, this is with the aim to make a responsible design with the environment and considering a better integration of the design in a site with higher potential and big influence from the heritage side.

From the site selected, four nearby buildings that had a visual impact were selected as a sample to used it for further parametrization input, therefore, by applying a façade analysis of each it would give more valuable elements to conduct the pattern analysis. These buildings selected were located to both sides of the site, at the back and adjacently. With this, it was obtained a sample analysis of the surroundings from the site.

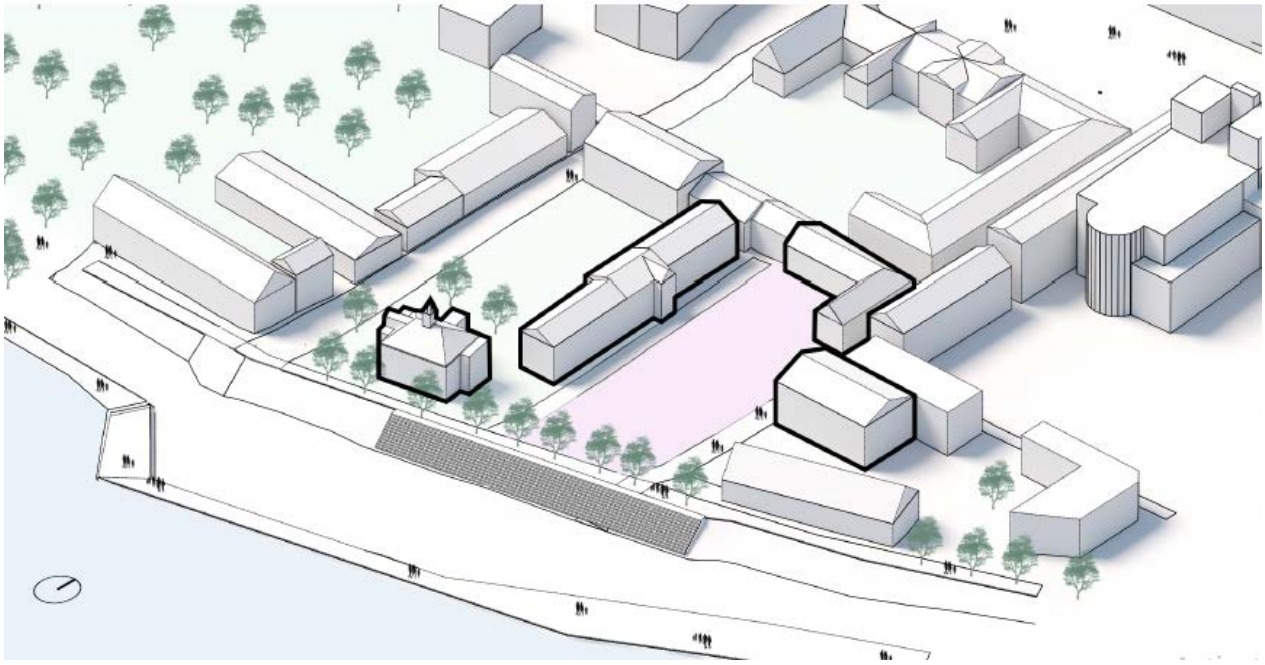


Fig. 105. Site proposal nearest buildings selected to analyze by author

Analyzing patterns implied understanding and recognizing the different orders they represent. For example, a pattern is usually identified with nodes in a graph, which is connected by edges of different lengths. A coherent combination of patterns will form a higher-level pattern that would possess additional properties (Hillier, Space is the machine, 1999).

Pattern combinations on a smaller level acquires new and unexpected properties that are not present in the constituent patterns. Failures present in describing a complex system are due to not allowing for enough levels. Losing them irremediably damages the way a society functions because architectural patterns help to define all the higher-level patterns. Sometimes a pattern might have an unwanted secondary characteristic. The same pattern is expressed as two different features (Bill Hillier, 1984).

In the chapter 2 based on the results from the space syntax analysis, demonstrate that the drawing part had a crucial effect in the results due to was made manually over the process of element identification (Jake Desyllas, 2001), from that perspective the image sampling methods in the cases studies demonstrate a better path to interpretate the façade as a conjunction of elements and this performing decreases the time consuming from CAD implementation (Xintao Liu, 2012). For that reason, in this stage it was used the CAD software Rhino with the plugin Grasshopper, due to will allow to obtain an image sampling from the façade and will allow to parametrize the pattern from the façades.

Grasshopper components allow to do image sampling based on chromatic values into a grid system and node points with numerical values going from 0 to 1 in the sense of their RGB information (Tedeschi, 2014) with the image sampling is possible to obtain a geometrical pattern based on true information from the image sample.

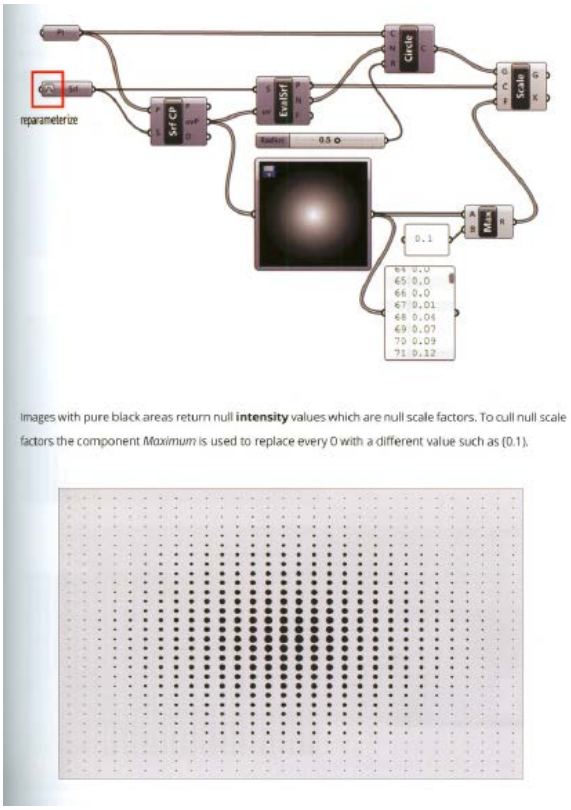


Fig. 106. Image sampling example (Tedeschi, 2014)

3.3.1. Voronoi fractal definition

The pattern geometry applied to the selected buildings through the image sampling was based on the Voronoi approach (Bristol, 2020). This method consists of generating a space-filling topological structure, it is one of the most fundamental and useful constructions defined by irregular lattices, emphasizing its excellent applicability in modelling natural phenomena, the investigation of their mathematical geometrical, combinatorial, and stochastic properties, and its computer-based constructability and representation.

The Voronoi approach subdivides the whole space into a set of sub-spaces according to the distribution of the objects. Each vertex represents the center of a Voronoi-cell and thus has its own

Voronoi space which defines implicitly the spatial adjacency with the adjacent objects (or the "influence space" of the objects). Within the Voronoi-cell, contained locations are closer to that object than to any other and thus create a spatial relationship.

The Voronoi diagram is a system that divides the space into sub-spaces in an organic way. His approach took from inspiration the wings of a dragonfly. To create this design the following steps are applied:

a. A set of given points are taken
b. A Delaunay triangulation if created for the given points
c. From the triangulation a Voronoi diagram is formed
d. The center of the circle of the triangle is determined
e. And the center of the circles determines the vertices of a convex polygon, making the diagram a dual graph.

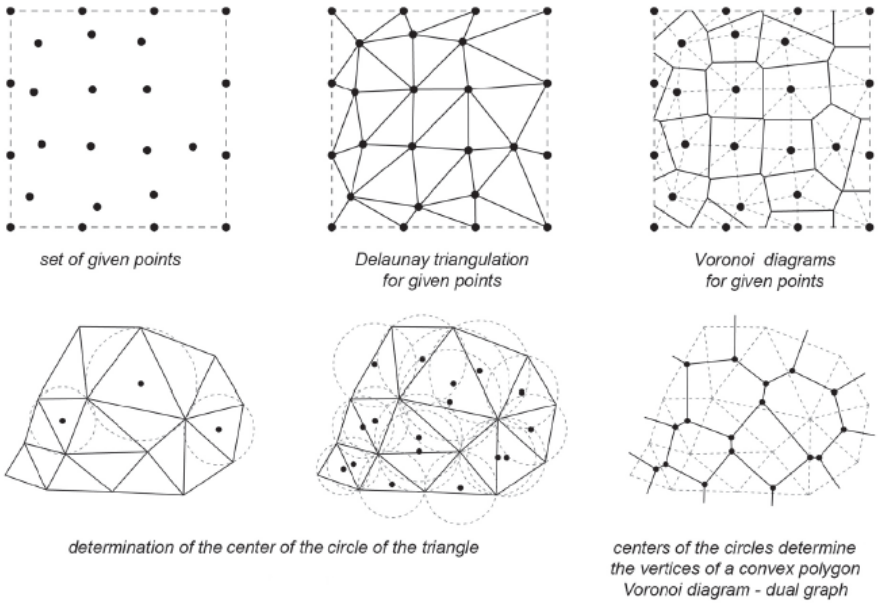


Fig. 107. Voronoi cells description (Bristol, 2020)

Since Hillier mentioned that any axial lines can go through the convex areas (Bill Hillier, 1984), Voronoi structures interconnect in a natural way the fractal geometry from the convex spaces through the image sampling results, for that reason the reinterpretation from his proposal allows to improve a new way to combine the interpretation from the façades implementing the image sampling combined with the Voronoi grid structure through the facades, previously tested in urban configuration as Turner mentioned on his conception (Alasdair Turner, 2005) from the previous statement, it was include in the next visual code the Voronoi cell image sampling code:

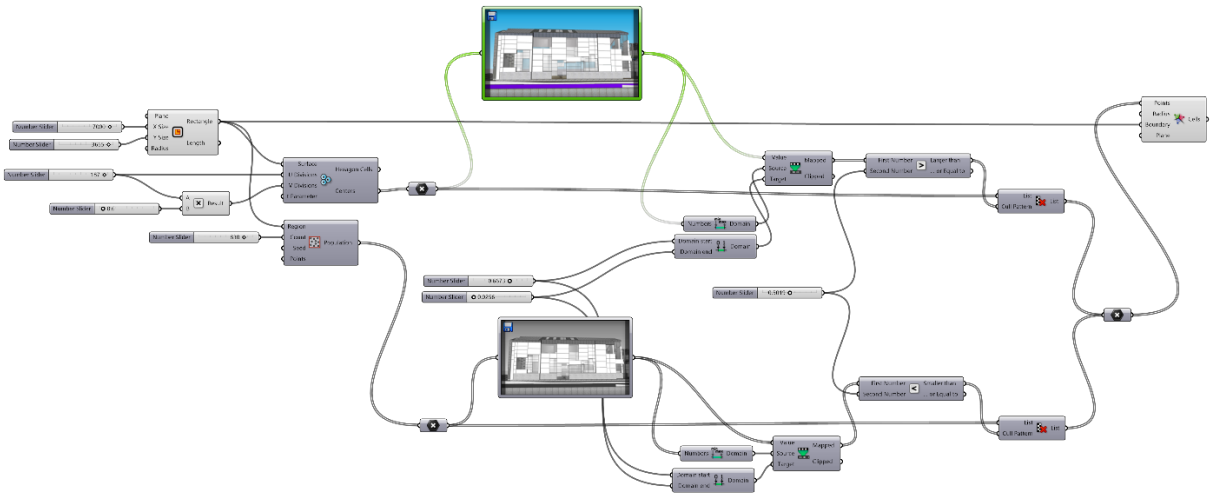


Fig. 108. Voronoi image sampling grasshopper script by author

3.3.2. Façade analysis of the nearest site buildings

After the application of image sampling implementing the Voronoi structure in each selected building it was applied the analysis with the space syntax tool on the facade Voronoi geometry, using axial map and segment map.

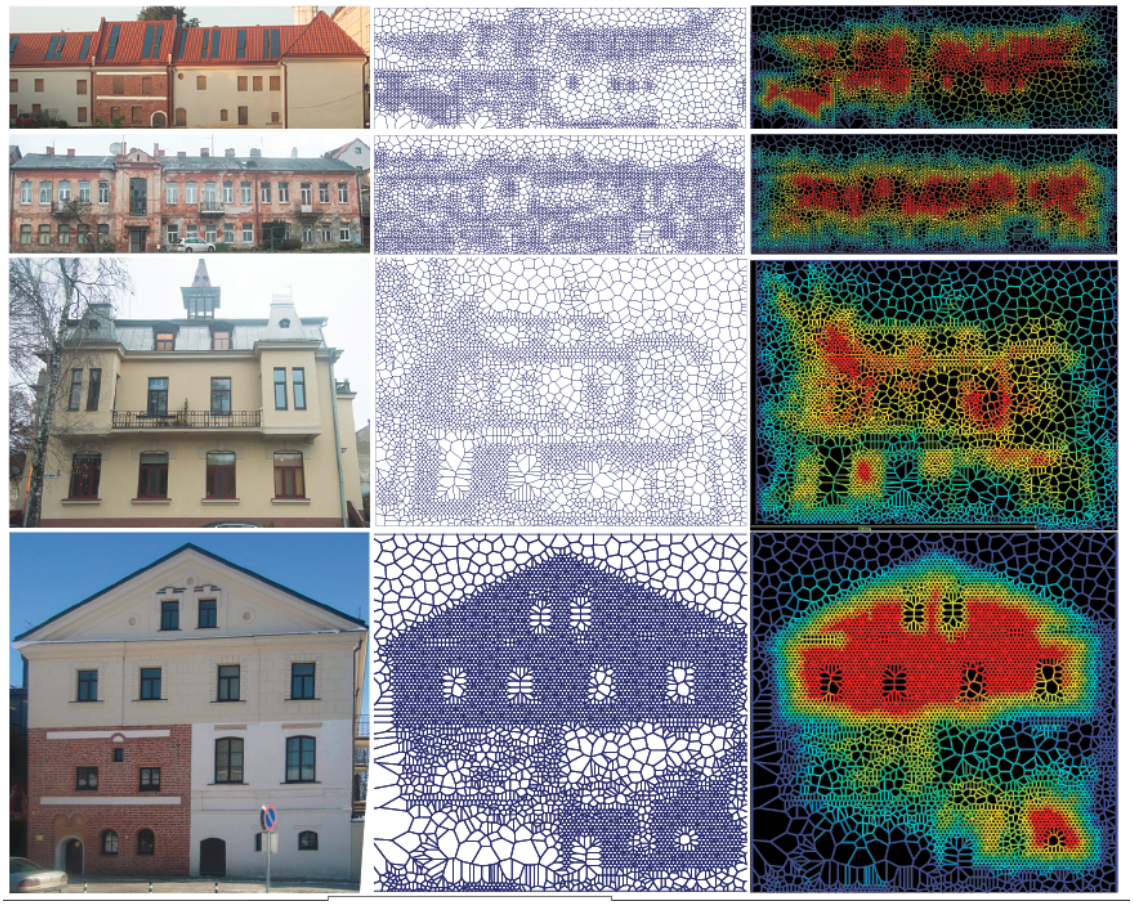


Fig. 109. Façade analysis by author. Left column represent the picture from the buildings, middle column represents the image sampling from grasshopper and the right column represents the result from space syntax tool

The results from the space syntax were classified through the software ArcGis to identify the points and pattern from each façade.

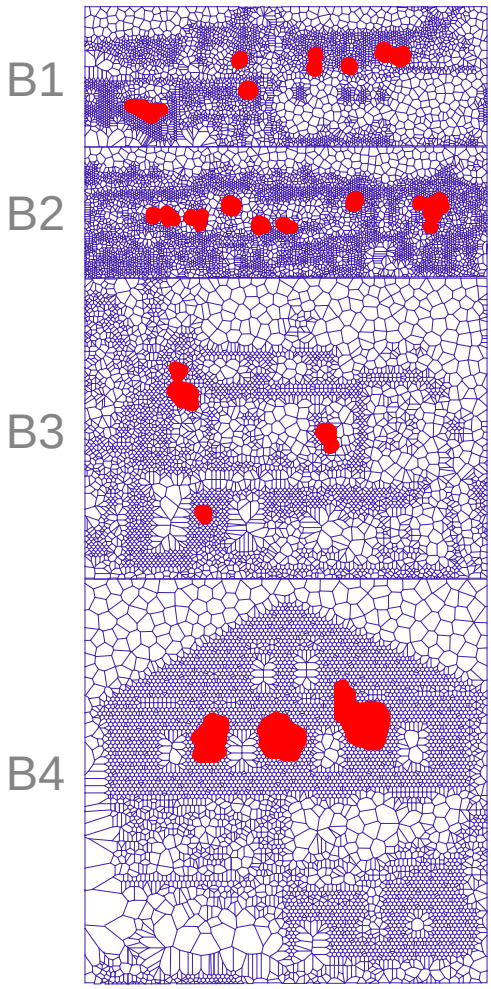


Fig. 110. Nodes from space syntax analysis in façade by author. Red points represent the most integrated values from the analysis.

From the previous image the pattern relies in the windows, doors and main entrance from the dots, the reinterpretation suggests a hierarchy position in horizontality, main entrance and rhythm from the windows, these ones reveal the inner language that C. Alexander mentioned in his patterns. (Christopher Alexander, 1977), due to there is not right answer from the pattern used in buildings it was considered the statement from C. Alexander about the connection of pattern with the interior and social activity, philosophy already mentioned by Rem Koolhas at the moment to design a building (Rem Koolhas, 1995).

The pattern parametrization was achieved through the paneling façades script due to this allow to arrange the areas for the living activities based on the architectonic program. The procedure started with the alignment of façade Voronoi structure, were a line described the wave from each element, is important that this is one method to retake the pattern from the façade, subsequently in Grasshopper façade testing were held in the aim to observe the most accurate approach with the building.

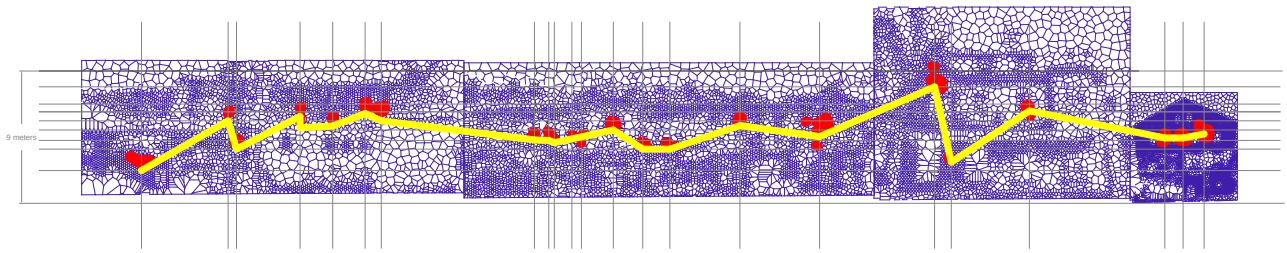


Fig. 111. Point alignment over facades by author

From the building heigh information around 9 meters the line drawn provides a path to implement in the grasshopper script, where this one was elaborated with the objective to create the panelisation, after attractor points from the nodes in the façade or the line were added to reconfigure the result from the panelisation. The attractor point is a fundamental aspect due to extract the data from the panelisation, making the result in terms of appreciation more visual. To clarify the term attractor through the software, this is understood as a geometric entity, that could be a point or curve that modifies the geometry in some predefined limits (Tedeschi, 2014)

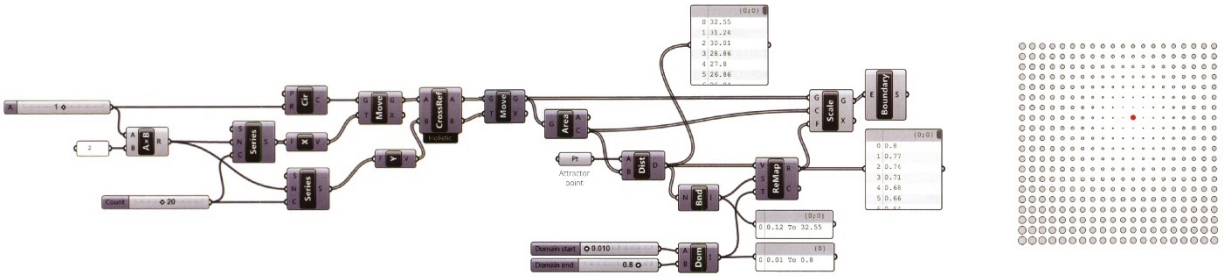


Fig. 112. Script of attraction point (Tedeschi, 2014)

The attractor points were parametrized over a plane of x and y, setting the points from in the sample, from the previous figure 111 where each point in the coordinate system was set under the parameter of localization joined by a polyline.

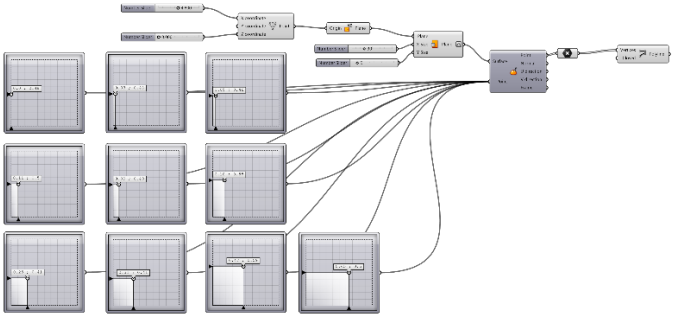


Fig. 113. Visual code script from sample points over the façade patterns by author

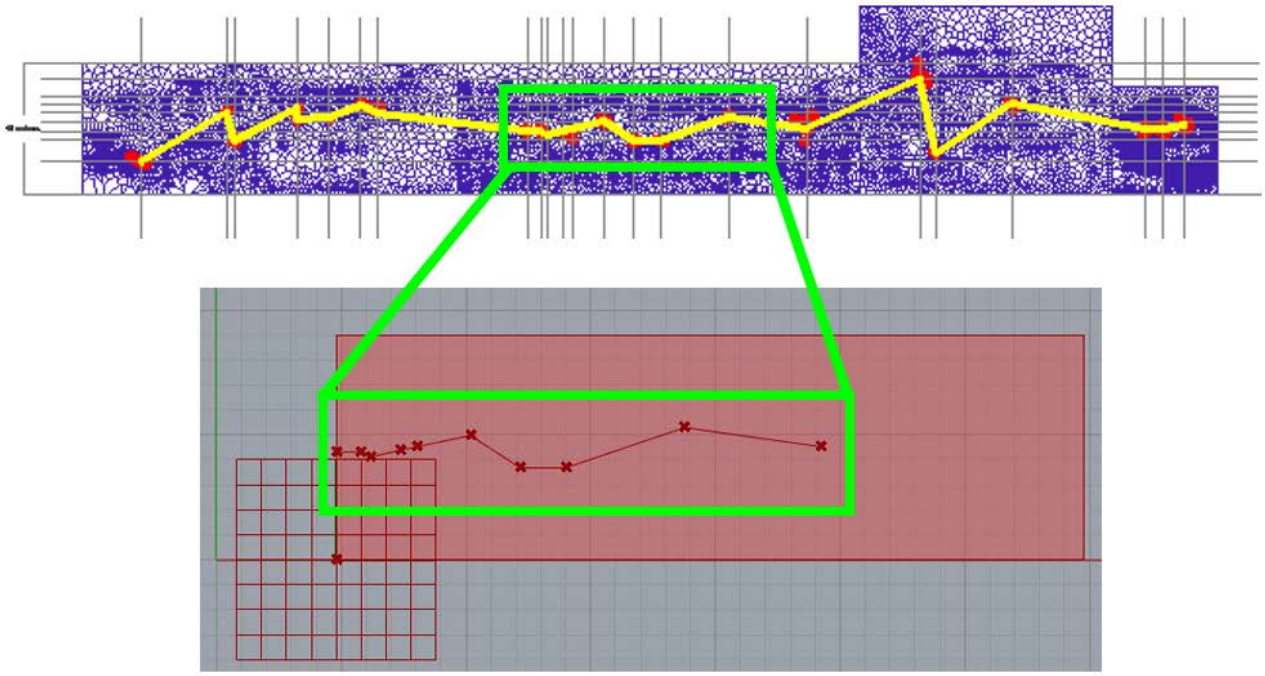


Fig. 114. Emulation from the pattern façade points generate as attractor points/line by author

The selection from the sample was set under the homogeneity from the façade alignment, this pattern will be used to generate different the panels and consequently to measure their quality in the application of the design.

The panelisation was made in 3 examples to experiment which model could generate betters results in the design in general views without proper scale and proportion.

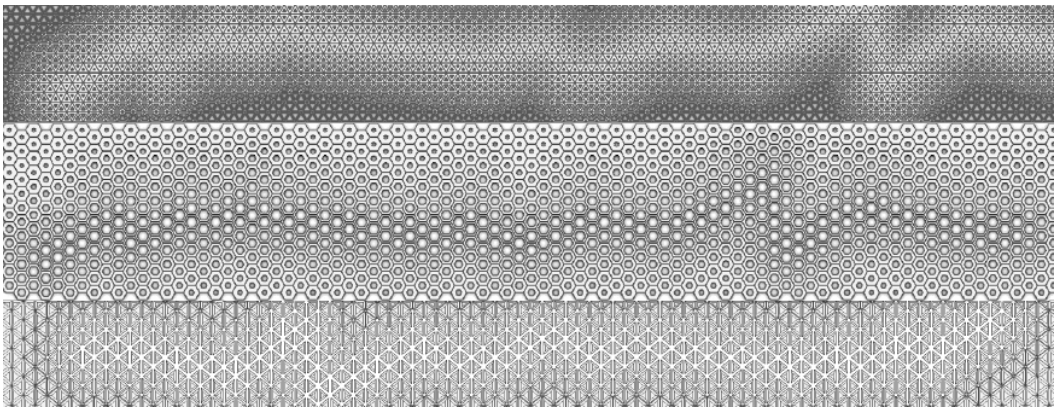


Fig. 113. Façade panelling options testing by author

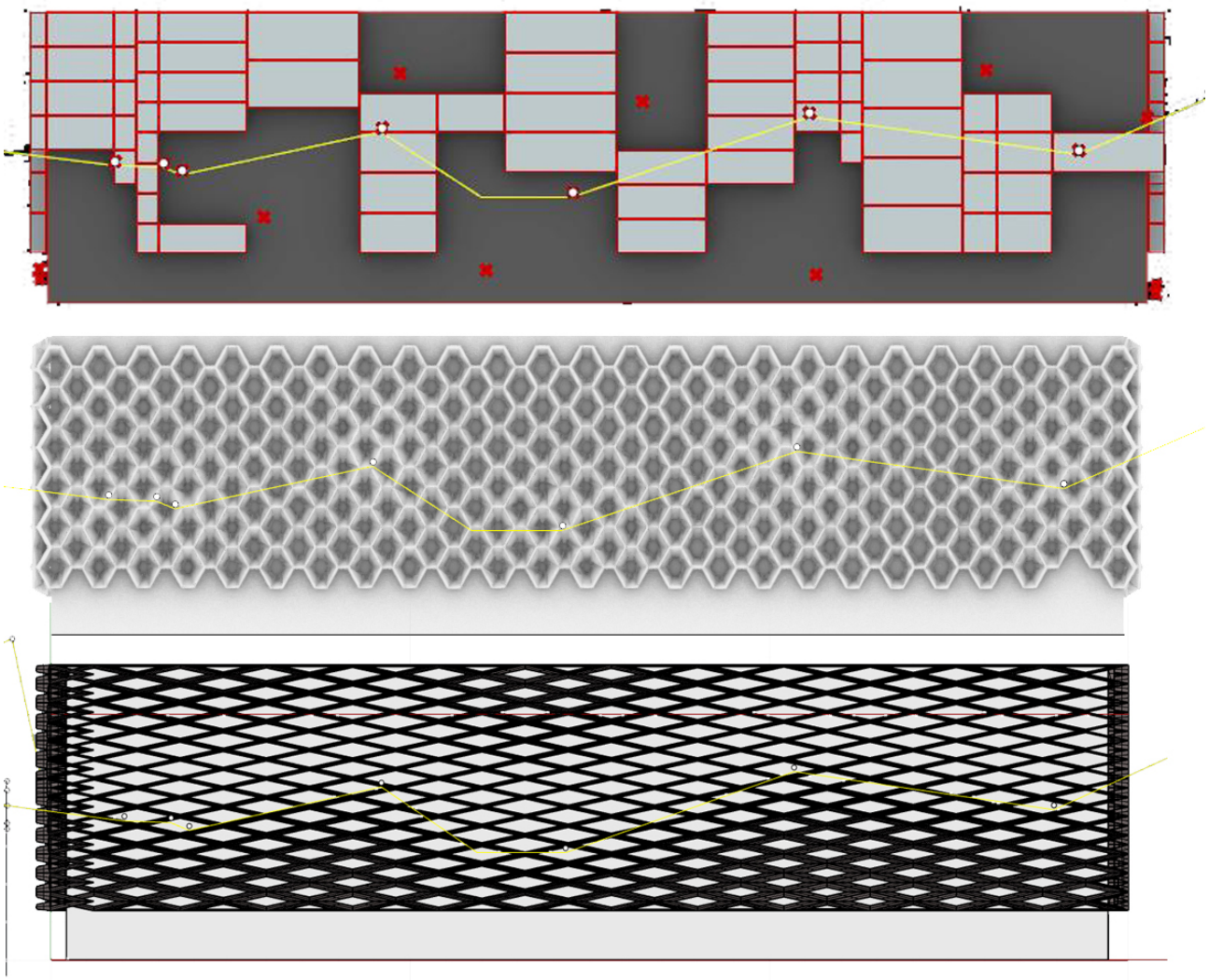


Fig. 115. Paneling application in the façade by author

After the paneling examination as a complement for the design the previous testing two of them did not provide a good point to connect with the statement of social spaces for that reason, it was selected the rectangular paneling option because the pattern is visible, the space allows the connection with the areas in the architectonic program.

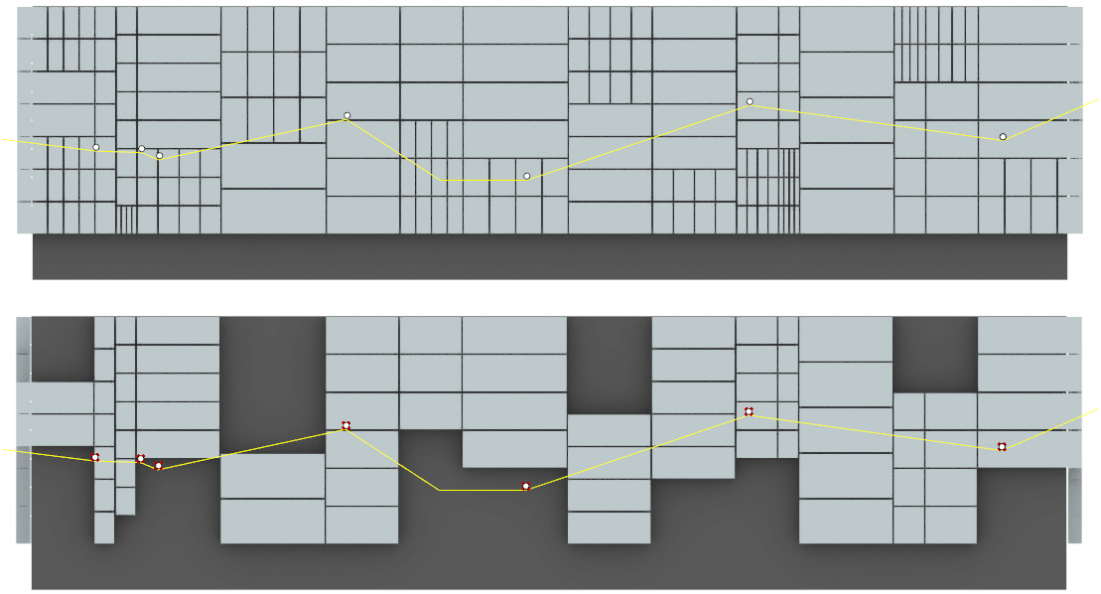


Fig. 116. Paneling structure after the attractor points location from the pattern façade sample by author

In the previous figure is notable how the pattern covers importance due to the subtraction of elements over the façade, revealing a new approach from a method that is currently in use.

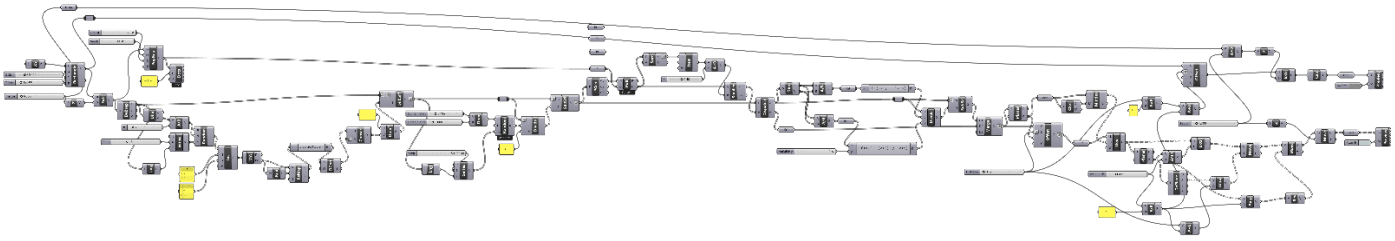


Fig. 117. Paneling script image by author

The script is divided in three main parts in the beginning from left to right is defined the area from the building, later points over the extrusion volume create the grid for the panelisation through the cloud points, subsequently in the middle of the script was set the size of the panel and the randomization of the size over the main volume box, a center point from each square is located in this part the point from the pattern façades are include, in this case it was used the sample made it from the fig. 117 to parametrized it as an attractor point over the panels and the last part in the right is the movement off all the panels block, thickness and materials application.

After the parametrization through grasshopper the model was exported to other software to realize the layouts and subsequently create the project visual information, however the model previously implemented is a different path to parametrize patterns and obtain valuable information to enrich the design process of any building design.

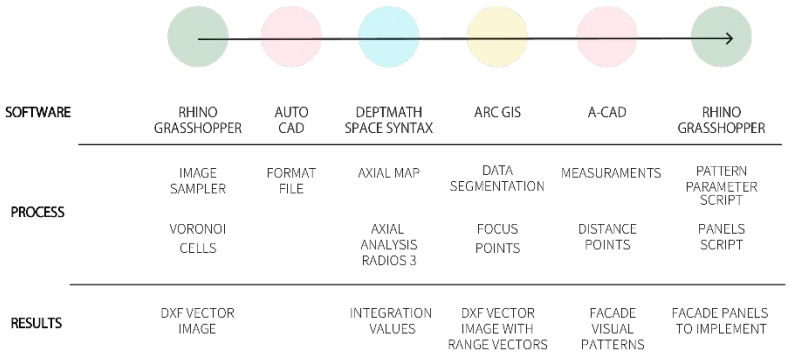


Fig. 118. CAD parametrization visual map by author

The previous figure represents in resume the utilization from CAD tools available until today to process data in terms of graphical and architectural design.

3.4. Multifunctional building design proposal

Fig. 119. Exterior perspective by author

The building is divided in 3 main floors, one underground, one ground floor and a first floor in two separate buildings. The underground floor contains the area for the museum and the service area considering that expositions and installations movements. The ground floor contains in the first building near to the river the conference room, the cafeteria, common area, toilets, bookstore area and the terrace/square meanwhile the second building near to the City Town Hall contain the startup area, toilets, and the parking plot. The first floor in the building No.1 contains the reading area and the building No.2 contains the workshop area, the administration, and the toilets area.

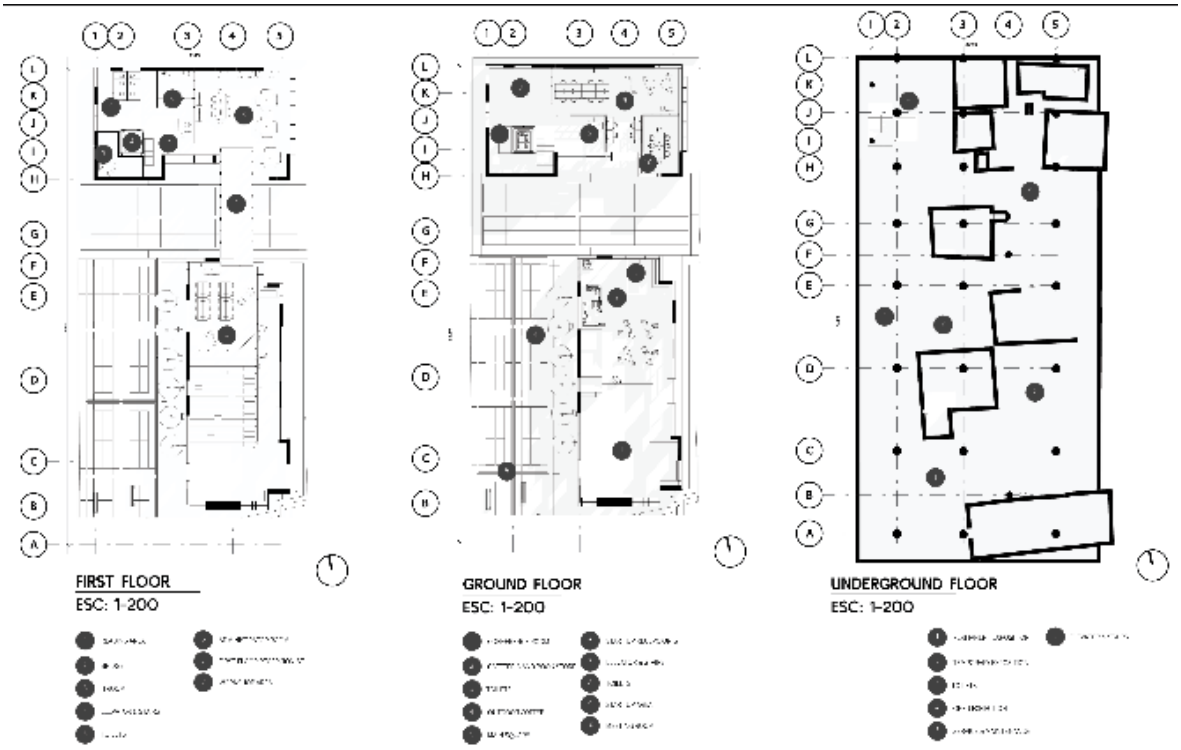


Fig. 120. Floor plan layouts by author

The concept in the interior of the museum is to have a higher fluency in the interior space holding permanent and temporary exhibitions. The museum is a resemble from the port history that the place used to have back in times. The material used in the underground museum where: floor is made by concrete polished; exteriors wall is made by concrete cast in situ, the interior walls from the archeological are preserved based on the regulations for preservation and maintenance from the city policies. The ceiling is by the concrete floor from the ground level, sustained by the columns grid. Illumination and HAVC system are connected to the ceiling part.

The ground floor was proposed to enhance the square and inner courtyard that the buildings layout used to present in the neighboring structure as an element to integrate the building in the city framework. The material used were concrete aggregate exposed, polished and broomed concrete, the sidewalk part had the local material for finishing such as the concrete blocks for the pedestrian area and the stone bricks for the edge of the sidewalk. Exteriorly, exterior lights with minimalism style were set, bench with presence of wood and granite finishing are in the south part and gardening area around the west park in the square, a relevance aspect is the allocation of security glass in the area to illuminate naturally the museum and interconnect visually the underground activity with the ground floor.

The first floor was set to connect the two buildings through a bridge to merge both zoning into one compound building. In the building 1 the reading area had a capacity over 30 people this connects visually with the interior along the crystal curtains walls generating an enhancing view through the area.

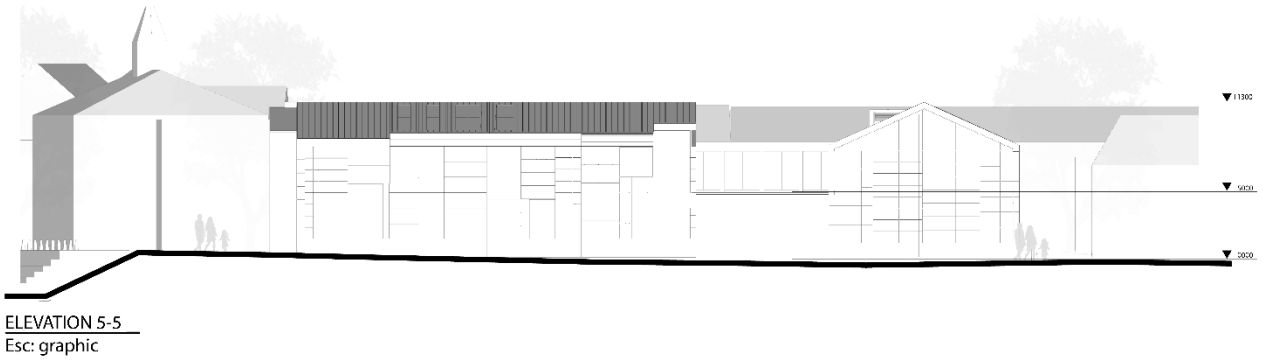


Fig. 121. Elevation 5-5 from multifunctional by author

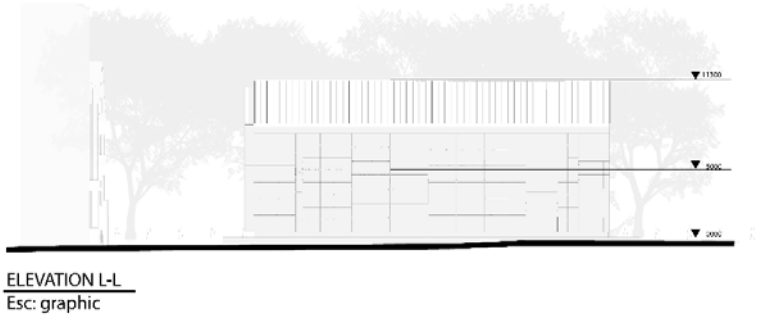


Fig. 122. Elevation L-L from multifunctional building by author

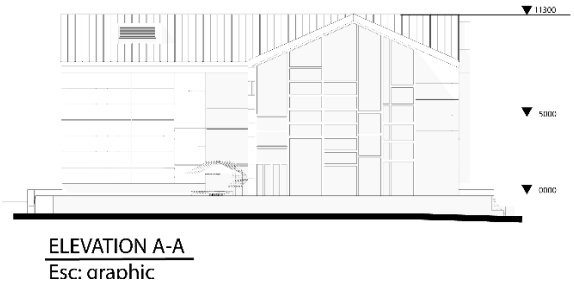


Fig. 123. Elevation A-A from multifunctional building by author

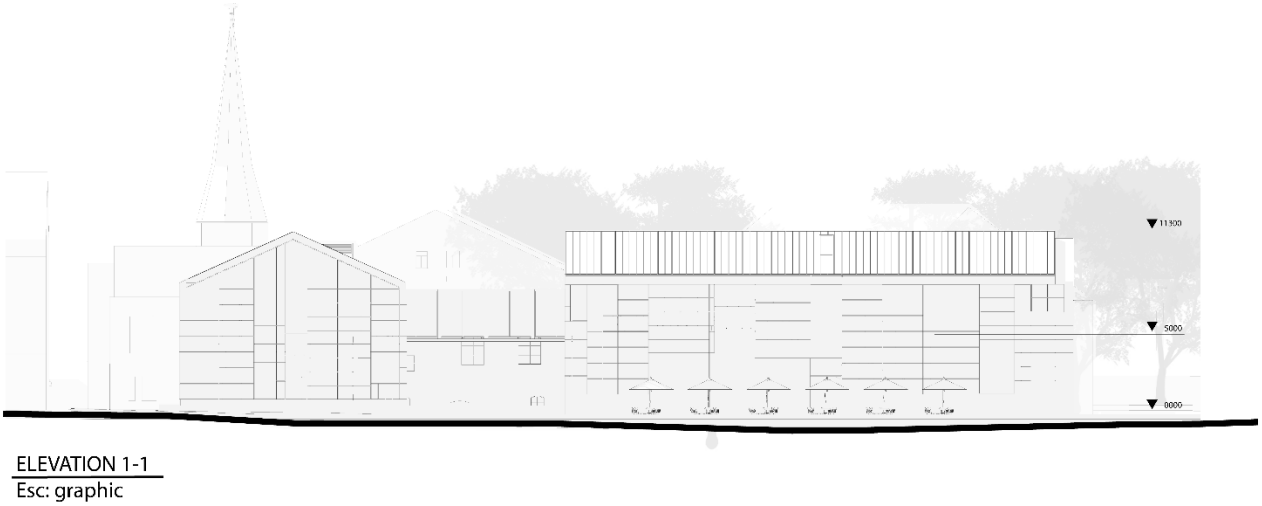


Fig. 124. Elevation 1-1 from multifunctional building by author

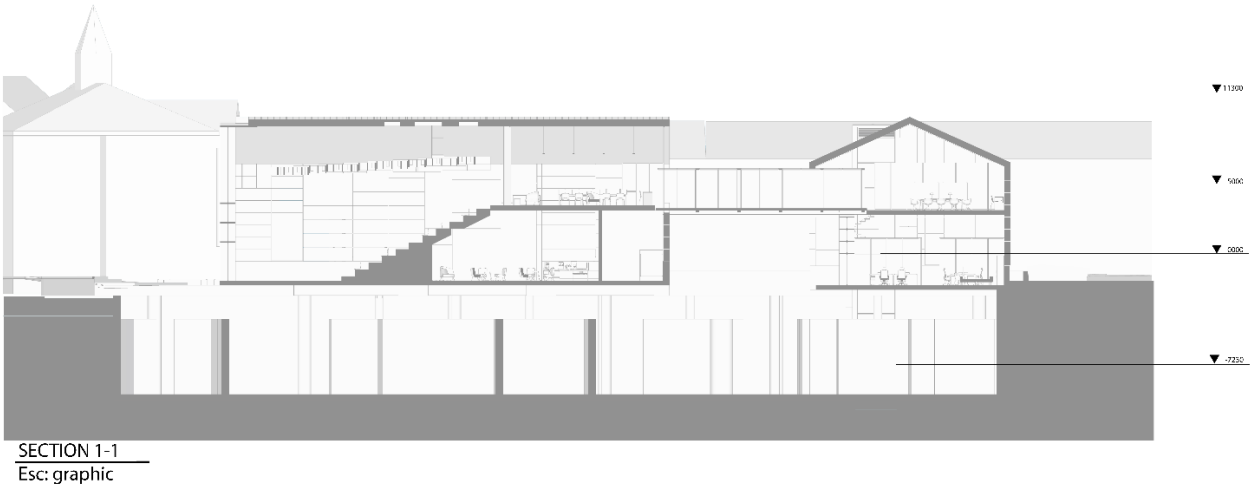


Fig. 125. Section 1-1 from multifunctional building by author

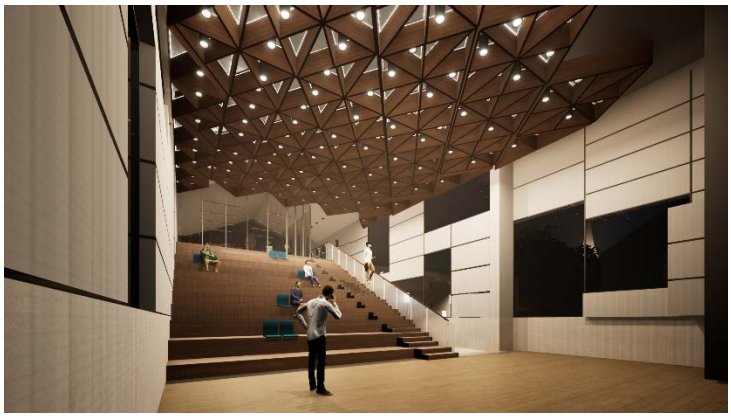


Fig. 126. Interior perspective from multifunctional building

3.5. Final evaluation from the pattern façade application in the multifunctional building

After the previous implementation design, it was evaluated the façade from the pattern façade sample, to evaluate they correspondence and similarity, with the aim to demonstrate the parametrization result over the process of building creation, repeating the CAD procedure as it was made with the nearest building to the design proposal.

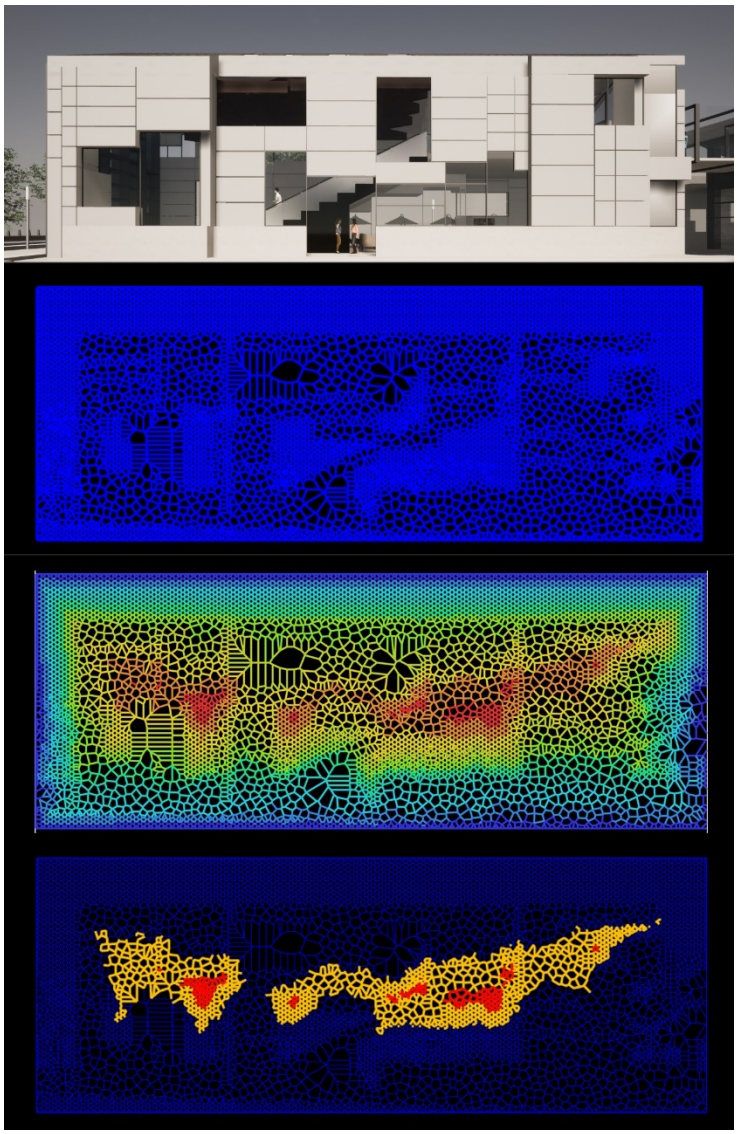


Fig. 127. Patterns points from the façade proposal by author

From the previous picture is notable the pattern that comes from the space syntax analysis, demonstrating the integration from the pattern and subsequently it was extracted the data to compare from the pattern sample.

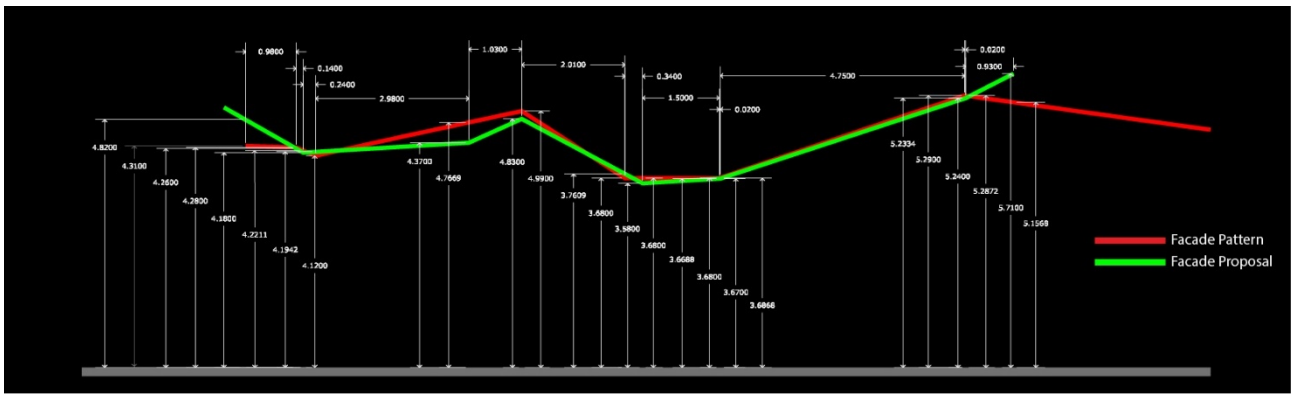


Fig. 128. Façade patterns comparison by author

Based on the previous analysis it was compared both pattern lines, it was measured the distance from the left side for each point and marked as an “x” value, then it was measured the distance between the point and the ground from each line to get the “y” values over both lines, this data was tabulated in excel for comparison, were the façade pattern is the red line used to create the script in the design stage and the green line is the line from the render image of the design through the integration values on space syntax tool.

Table 19. Points position and difference values from pattern lines by author

	Point	X	Sample Y	Result Y	|diff|	% Difference
Comparison	P1	4.8	4.31	4.82	0.51	12%
	P2	5.78	4.28	4.26	0.02	0%
	P3	5.92	4.22	4.18	0.04	1%
	P4	6.16	4.12	4.19	0.07	2%
	P5	9.14	4.77	4.37	0.4	9%
	P6	10.17	4.99	4.83	0.16	4%
	P7	12.18	3.68	3.76	0.08	2%
	P8	12.52	3.68	3.58	0.1	2%
	P9	14.02	3.68	3.67	0.01	0%
	P10	14.04	3.69	3.67	0.02	0%
	P11	18.79	5.29	5.23	0.06	1%
	P12	18.81	5.29	5.24	0.05	1%
	P13	19.74	5.16	5.71	0.55	12%
Total			57.16	57.51	2.07	

Average difference	0.16
Average percentage of difference	4%

The table summarizes the values taken from the comparisons distance made in auto cad, it was taken in consideration the average difference as an absolute value and percentage giving a 4% of difference from all the test, that it could be interpretated as a good factor in terms that the patterns lines match between each other.

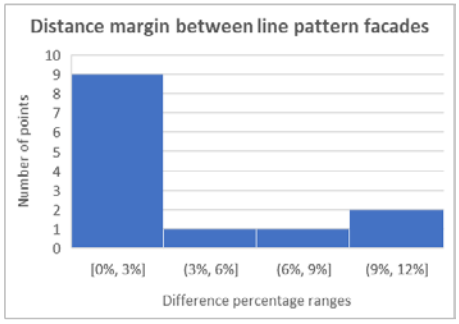


Fig. 129. distance margin bars graph by author

In the previous chart it was noted that from the total of points 9 of them had a difference between 0 and 3% in comparison with the rest of points that were between 3% and 12%.

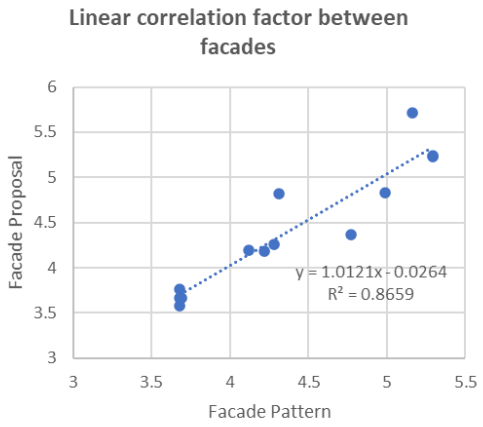


Fig. 130. Correlation between line facades by author

The correlation between the façade sample line and the proposal is 0.86 even though that the sample is short demonstrate their correspondence along the analysis, meaning that the application of patterns could be performed by parametrization values.

3.6. Conclusions from experimental design application

1. In order to be close to finding an answer for the hypothesis, from the research and the literature analyzed, it was conclude that the possibilities of this study, after analyzing the object patterns presented by Alexander, allow the identification and later the name of compositional attributes from the patterns, mentioned before, like symmetry due to the fact that it is the first one and the most clear to understand from the mathematical point of view, demonstrating that is possible and feasible to find a path to make a further analysis between the interconnections that the objects could have, nevertheless it is need it to be aware that not all the attributes in the space allocated in the objects can be translated, because patterns have different properties like interconnection and hierarchy, for that reason some patterns' attributes could lack in one or more of them, creating the challenge to split the layers in the object.

2. Considering that nowadays the architectural production is related to all types of designs, the selection of samples for nearest analysis should be a prior statement in the future considering that this type analysis should run in objects that present clear composition characteristic, due to the object richness is based on composition quality. For that reason, the samples should not differ in typology, considering that the scope of a house will not the same like another type of building such as a school, but that does not mean that the sample selection could not have a variation on building styles, in correspondence, styles should not be a problem in the sample selection because each style runs in the same principles of "theory of architecture" and in consequence in attributes, but far from that point, some typologies ensure a better analysis to use in the pattern identification, as a result, this selection should be discussed and revised with the prior to ensure future results.

3. The analysis of the research was made in 2d conception through the façades in order to facilitate the exploration in a planar point of view, but that does not mean that the consideration of the 4 facades of the building will give some valuable information that later on should be re interpreted, considering that each element from the object represent information, and their compound all the interesting data from the building.

4. For that reason, objectivity should lead the aim to represent the real attributes that the objects could have, and the setting of values, because they should come from the users and designers through surveys and questionnaires, considering that setting the values should not become in bios, should become from the interpretation, with that information, for that reason it was can consider a value evaluation, using binary expression to set the values for the analysis, and represent the results between them. From one side is to get information that run-in appreciation and the other one base on correspondence of factors, if it is decided that they contain symmetry it is possible set the prior of 1 and if does not have we can set the prior of 0, creating a hierarchy of results, working in the different layers mentioned before, but mostly as a prior will go on vertical and horizontal direction, creating a logic statement of evaluation.

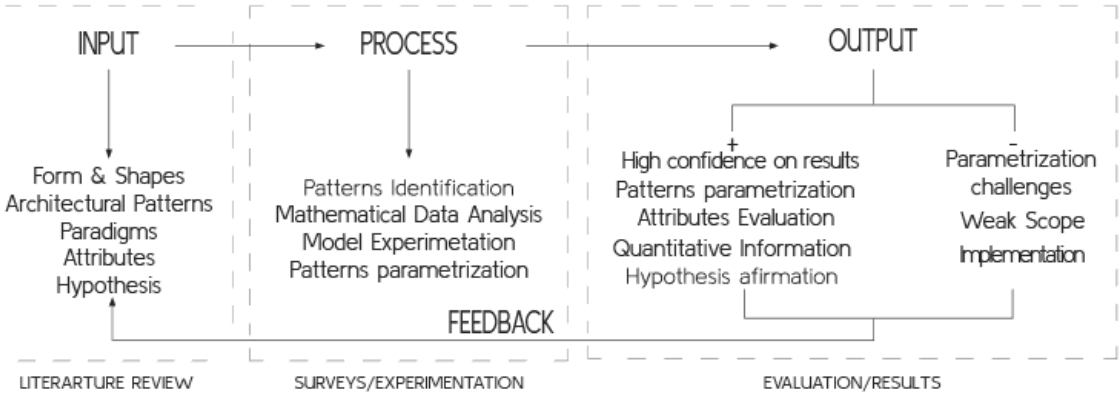


Fig. 131. Conceptual model after experimental results by author

Conclusions

1. After the theory revision, it can be argued based on the C. Alexander pattern theory and Hillier statements that a designed object has the possibility to be examined through a model, the research demonstrates the importance and relevance to investigate the relationship over different paradigms, considering that each paradigm contains its own theory of architecture application and these ones are structured through different composition attributes; nevertheless, is important to mention for future investigation a sub-classification under each paradigm in the way to analyze more precise data source in order to understand the people's perception.

2. Mostly parameters application in design examples are used in façade skins looking at how aesthetics influences the exterior and not the interior, meanwhile, other contemporary parameter techniques tend to seek results without the context inclusion. Through the investigation was demonstrated that the parameter technique potential can relate to a responsive analysis from patterns of the nearest buildings meaning that this inclusion in the procedure of design has more potential in the sense to add more structured parameters, because they had the possibility to include more aspects and conduct more complex operations.

3. Hillier model is the most promising to generate mathematical contributions and reliable data based on graphical interpretations, in the research the model presented the inconvenience of subjectivity at the moment of value assignation before to run any analysis discovered in the facades, for that reason the implementation of actual tool based on image sampling allows to improve the bias from the human interpretation through a net based on fractal structure on polygons, demonstrating in this way the sensitivity capacity that models drawing could have from the objects.

4. Based on the results and analysis exist the possibility to connect the indices that the building could have through a formulation where the summatory of indices based on the discoverable elements can generate a path to collect in terms of data the value indices from the buildings, meaning that each building score could represent an important insight for further analysis and studies in the relationship of aesthetics quantity vs quality.

5. It was found, a strong correlation between the connectivity of the lines that represent the elements in the façade with the value of attraction from the sample survey, referring that, in sense of style, the more integrated the building, the more it is appreciated and ranked. That means meanwhile a building demonstrate a better integration from its composition attributes e.g., a notable and harmonious rhythm, it will show a higher integration value in that nearest area and people will tend to appreciate better in terms of focus points and aesthetics.

6. The application of architectural patterns through parametrization in the building design has the potential to be explored through form finding and generative design, considering that patterns are like fractals and the property of scale had the possibility to create interesting shapes in different buildings size and typology. Properly tested in the re parametrization from the building's patterns in short margin of desviation and a high factor of correlation between the samples and the results pattern, proving the architectural patterns had the possibility to be implemented through the design stage, doing a more responsive and adaptive design in the surroindings and cities in general.

List of references

1. Hillier, B. (2011). Is Architectural Form Meaningless? *The Journal of Space Syntax*, 125-153.
2. 2016, A. o. (2020, May 13). *Atlasofurbanexpansion*. Retrieved from Atlasofurbanexpansion: http://atlasofurbanexpansion.org/cities/view/Kaunas
3. Abbs, P. (2005). *The Symbolic Order: A Contemporary Reader On The Arts Debate.* Routledge.
4. administration, K. C. (2020, August 25). *Kaunas*. Retrieved from Kaunas: http://en.kaunas.lt/business/investment-projects
5. Alasdair Turner, A. P. (2005). An Algorithmic Definition of the Axial Map. *Environment and Planning B: Planning and Design*, 425-444.
6. Alban Janson, F. T. (2014). *Fundamental Concepts of Architecture.* Germany: Birkhäuser Verlag GmbH, Basel.
7. Alexander, C. (1973). *Notes in the synthesis of the form.* Harvard University Press.
8. Alexander, C. (1977). *A pattern language.* Oxford University Press.
9. Alexander, C. (1979). *The Timeless Way of Building.* Berkeley: Oxford Universty Press.
10. Allen Klinger, N. A. (2000). A Pattern Measure. *Research Gate,* 537-547.
11. Amal Osama, L. S. (2014). Fractal geometry in architecture: from formative idea to superficial skin design. *Research Gate*, 39-49.
12. Amal Osama, L. S. (2014). Fractal geometry in architecture: from formative idea to superficial skin design. *Contemporary Discussions and Design Methodologies in Architecture ARCHDESIGN* (pp. 39-49). Istanbul: ARCHDESIGN ‘14.
13. Archdaily. (2019). *https://www.archdaily.com*. Retrieved from https://www.archdaily.com: https://www.archdaily.com/59719/ad-classics-the-farnsworth-house-mies-van-der-rohe
14. Armin Bunde, S. H. (1994). *A Brief Introduction to Fractal Geometry*. Springer, Berlin, Heidelberg.
15. Ashley Dhanani, L. V. (2012). From the axial line to the walked line: evaluating the utility of commercial an user-generated street network datasets in space syntax analysis. *Eighth International Space Syntax Symposium.* Chile: UCL.
16. Bacon, E. N. (1974). *The Design of Cities.* New York: Viking Press.
17. BBC. (2014, Diciembre 18). *www.BBC.com*. Retrieved from BBC: https://www.bbc.com/news/magazine-30438180
18. BBC. (n.d.). *www.bbc.com*. Retrieved from www.bbc.com: https://www.bbc.com/culture/article/20130423-design-icon-or-concrete-horror
19. Bill Hillier, J. H. (1984). *The social logic of space.* New york: Cambridge University Press.
20. Bin Jiang, J. Y. (2014). Ht-Index for quantifying the fractal or scaling structure of geographic features. *Annals of the Association of American Geographers*, 530-540.
21. Bristol. (2020, December). *bristol*. Retrieved from bristo: https://www.bristol.ac.uk/maths/fry-building/public-art-strategy/what-is-a-voronoi-diagram/
22. Britannica, E. (2020, November). *Britannica*. Retrieved from https://www.britannica.com/: https://www.britannica.com/art/Western-architecture/Architecture-at-the-turn-of-the-21st-century

23. Carnie, A. (2007). *Syntax : a generative introduction.* Massachusetts: Malden, MA : Blackwell Pub.
24. Carpio, M. (2012). *The digital turn in architecture 1990-201*. John Wiley & Sons Ltd.
25. Ching, F. D. (2007). *Architecture Form, Space and Order.* New Jersey: John Wiley & Sons, Inc.
26. Chris Tucker, M. J. (2005). Spatial configuration within residential facades. *The Fifth International Space Syntax Symposium. 5th International Space Syntax Symposium Proceedings* (pp. 769-770). Delft, Netherlands: Techne Press.
27. Christopher Alexander, S. I. (1977). *A Pattern Language: Towns, Buildings, Construction.* New York: Oxford University Press.
28. Clarke, P. (2014). *https://www.architectmagazine.com*. Retrieved from https://www.architectmagazine.com: https://www.architectmagazine.com/design/buildings/south-australian-health-and-medical-research-institute-designed-by-woods-bagot_o
29. Claudia Yamu, A. v. (2021). Bill Hillier's Legacy: Space Syntax—A Synopsis of Basic Concepts, Measures, and Empirical Application. *MDPI*, 13.
30. Corbusier, L. (1985). *Towards a New Architecture.* Dover Publications.
31. Crow, H. +. (2019). *https://www.inexhibit.com*. Retrieved from https://www.inexhibit.com: https://www.inexhibit.com/mymuseum/heydar-aliyev-center-baku-azerbaijan-zaha-hadid/
32. Crownover, R. M. (1995). *Introduction to fractals and chaos.* London: Jones and Bartlett Publishers.
33. Danius, S. (2019). *The Senses of Modernism: Technology, Perception, and Aesthetics.* New York: Cornell University Press.
34. departamentas, K. p. (2020, December). *Kultūros paveldo departamentas*. Retrieved from Kultūros paveldo departamentas: https://kvr.kpd.lt/#/static-heritage-search
35. Eckert, C. (2000). Sources of inspiration: a language of design. *Science Direct*, 532-533.
36. Economou, A. (2018). The Six Vitruvian Principles of Architectual Design Reframed Within Contemporary Computational Design Discourse. *Researchgate*, 118-119.
37. Edward Bullard, B. L. (1975). The Effect of World War II on the Development of Knowledge in the Physical Sciences [and Discussion]. *JSTOR*, 524.
38. Eisenman, P. (1984). *The End of the Classical: The End of the Beginning, the End of the End.* The MIT Press on behalf of Perspecta.
39. Emo, B. (2014). Seeing the Axial Line: Evidence from Wayfinding Experiments. *Behavioral sciences*, 167-180.
40. en.kaunas.lt. (2020, December). *en.kaunas.lt*. Retrieved from en.kaunas.lt: http://en.kaunas.lt/city/city-history
41. Farrelly, L. (2007). *The Fundamentals of Architecture.* Switzerland: AVA Publishing SA.
42. Feldman, D. P. (2012). *Chaos and Fractals: An Elementary Introduction.* Oxford University Press.
43. Galloway, A. (2005). Non-Probability Sampling. *Sciencedirect*, 1-6.
44. Garcia, M. (2009). *The Patterns of Architecture 1st Edition.* London: Architectural Design.

45. Goethe, J. W. (1839). *Conversations with Goethe in the last years of his life.* Boston: Boston : Hilliard, Gray, and company.
46. Grabow, S. (1983). *Cristopher Alexander The Search for a New Paradigm in Architecture.* Boston, Henley, London: Oriel Press.
47. Hassan A. Karimi, B. A. (2009). *CAD and GIS Integration.* CRC Press.
48. Hatice Karaçay ÇAKMAK, I. Ö. (2007). The basic dilemmas of the modernist development paradigm's view towards culture . *dergipark*, 61-64.
49. Hillier, B. (1999). *Space is the machine.* Cambridge: Syndicate of the University of Cambridge.
50. Hillier, B. (2011). Is Architectural Form Meaningless? *The Journal of Space Syntax*, 125-153.
51. HNIT-BALTIC, U. (2021, may 13/05/2021). *Maps.lt*. Retrieved from Maps.lt: https://www.maps.lt/map/#
52. Horn, R. E. (1998). *Visual Language.* Wahington: MacroVU, Inc.
53. IN, K. (2020, December). *kaunasin*. Retrieved from kaunasin: https://kaunasin.lt/why-kaunas/real-estate-map/
54. In, K. (2021, May 13). *It's Kaunastic*. Retrieved from It's Kaunastic: https://visit.kaunas.lt/en/see-and-do/top/kauno-pilis/
55. infr.kaunas.lt. (2020, December). *infr.kaunas.lt*. Retrieved from infr.kaunas.lt: http://infr.kaunas.lt/noise#
56. Ingrid D. Rowland, T. N. (2001). *Vitruviu Ten Books on Architecture.* Cambridge: Cambridge University Press.
57. Jake Desyllas, E. D. (2001). Axial Maps and Visibility Graph Analysis. *Space Syntax Third International Symposium.* Atlanta: UCL.
58. Jean-Michel Jolion, W. G. (1998). *Graph Based Representations.* Honk Kong: Springer-Verlag Wien.
59. Jeanneret, C. E. (1980). *Le Modulor 1 & 2.* United States: Harvard University Press.
60. Jiang, B. (2019). Christopher Alexander and His Life'sWork:. *Urban Science*, 2.
61. John Adams, H. T. (2014). *Research Methods for Business and Social Science Students (Second Edition).* SAGE Publications Ltd.
62. Julius Panero, M. Z. (2014). *Human dimension & interior space.* New York: Watson-Guptill.
63. Karatani, K. (1995). *Architecture as Metaphor_ Language, Number, Money (Writing Architecture).* The MIT Press (1995).
64. Klarqvist, B. (1993). A Space Syntax Glossary. *Nordic Journal of Architectural Research*, 11-12.
65. Klinger, A. (1999). A Pattern Measure. *Environment and Planning B Planning and Design*, 537-547.
66. Kus, D. O. (2014). *www.arc-magazine.com*. Retrieved from www.arc-magazine.com: https://www.arc-magazine.com/national-museum-of-qatar-qatar/
67. Lara, F. L. (2006). Brazilian Popular Modernism: Analyzing the dissemination of architectural vocabulary. *Journal of Architectural and Planning Research*, 91-112.
68. LaValle, S. M. (2021). *Virtual Reality.* Oulu: Cambridge University Press.
69. Lefaivre, L. (1986). *Classical Architecture The Poetics of Order.* The MIT Press.

70. Leszl, W. G. (2006). Plato’s attitude to poetry and the fine arts, and the origins of aesthetics. *Études platoniciennes*, 245-336.
71. Leyton, M. (2006). Shape as Memory A Geometric Theory of Architecture. In M. Leyton, *Shape as Memory A Geometric Theory of Architecture* (pp. 15-23). Berlin: Birkhäuser – Publishers for Architecture Basel .
72. London, U. C. (2021, March 30). *UCL*. Retrieved from UCL: https://www.ucl.ac.uk/bartlett/architecture/research/space-syntax/depthmapx
73. Loos, A. (2019). *Ornament and Crime.* Penguin Classics .
74. Lu, D. (2010). *Third World Modernism: Architecture, Development and Identity*. Routledge.
75. MacMillanDictionary. (2019, November 19). *McMillanDictionary Blog*. Retrieved from McMillan Dictionary Web Site: http://www.macmillandictionaryblog.com/paradigm
76. Mahbub Rashid, K. K. (2006). Spatial layout and face-to-face interaction in offices – A study of the mechanisms of spatial effects on face-to-face interaction . *Environment and Planning B: Planning and Design*, 825- 844.
77. Mandelbrot, B. B. (1977). *The fractal geometry of nature.* New York: W.H. Freeman and company.
78. Merriam-Webster. (2019, December 2019). *Merriam-Webster*. Retrieved from Merriam-Webster: https://www.merriam-webster.com/dictionary/parameterize
79. meteoblue. (2020, December). *meteoblue*. Retrieved from meteoblue: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/kaunas_lithuania_598316
80. Meteoblue. (2020, December 12). *MeteoBlue*. Retrieved from MeteoBlue: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/kaunas_lithuania_598316
81. Miles Reid, B. S. (2005). *Geometry and Topology*. Cambridge: Cambridge University Press.
82. Murray, P. (2003). *The Saga of Sydney Opera House.* London: Spon Press.
83. Nancy Al-Assaf, S. D. (2014). The Aesthetics symptoms of architectural form: the case of Barcelona Museum of Contemporary Art. *ARCHDESIGN ‘14* (pp. 3-6). Turkey: Researchgate.
84. Neufert, E. (2000). *Neufert Architects' Data 3rd Edition.* Wiley-Blackwell.
85. Norberg-Schulz, C. (2000). *Principles of Modern Architecture.* Andreas Papadakis.
86. Peddie, J. (2013). *The history of visual magic in computers.* London: Springer.
87. Pelt, J. V. (1902). *A Discussion of Composition.* New York: The Macmillan Company.
88. Pickvance, C. G. (2001). Four varieties of comparative analysis. *Journal of Housing and the Built Environment*, 7-28.
89. Pielage, A. (n.d.). *Curbed New York.* Retrieved from ny.curbed.com: https://ny.curbed.com/2019/10/18/20920836/nyc-museums-guggenheim-frank-lloyd-wright-architecture
90. PLANAS, K. (2020, December). *maps.kaunas.lt*. Retrieved from maps.kaunas.lt: https://maps.kaunas.lt/bp/
91. Portal, O. S. (2020, May 13). *osp.stat.gov.lt*. Retrieved from osp.stat.gov.lt: https://osp.stat.gov.lt/en/lietuvos-regionai-2020/lietuvos-apskritys/kauno#

92. Rem Koolhas, B. M. (1995). *S,M,L,XL*. New York: Monacelli Press.
93. Ripperda, N. (2008). Determination of facade attributes for facade reconstruction. *International Society of Photogrammetry and Remote Sensing*, 285-290.
94. Ruane, J. M. (2005). *Essentials of Research Methods A Guide to Social Science Research.* Blackwell Publishing.
95. Rubinowicz, P. (2000). Chaos and Geometric Order in Architecture. *Journal for Geometry and Graphics*, 197–207.
96. Rudofsky, B. (1973). *Architecture without architects.* Buenos Aires: Buenos Aires University.
97. Ruohonen, K. (2013). *Matematiikan laitos.* Retrieved from Matematiikan laitos: http://math.tut.fi/~ruohonen/GT_English.pdf
98. Ruskin, J. (1880). *The Seven Lamps of Architecture* . Boston: New York, J. Wiley & sons.
99. Sá, J. M. (2001). *Pattern Recognition Concepts, Methods and Applications.* Portugal: Springer.
100. Salingaros, N. A. (1999). Architecture, Patterns and Mathematics. *Nexus Network Journal*, 75-85.
101. Salingaros, N. A. (2000). The Structure of Pattern Languages. In N. A. Salingaros, *Architectural Research Quarterly Volume 4* (pp. 149-161). San Antonio: Cambridge University Press.
102. Salingaros, N. A. (2012). Fractal Art and Architecture reduce physiological stress. *Journal of Biourbanism*, 11-28.
103. Salingaros, N. A. (2014). Complexity in Architecture and Design. *Oz Journal*, 18-25.
104. Salingaros, N. A. (2017). *Design Patterns & Living Architecture.* Portland: Sustasis Press.
105. sąrašas, K. m. (2018, June 26). *Kaunas*. Retrieved from Kaunas: https://maps.kaunas.lt/gatves/
106. Sattrup, P. A. (2012). Architectural Research Paradigms – an overview and a research example. *Royal Danish Academy of Fine Arts School of Architecture*, 5-6.
107. Seyed Farhad Tayyebi, Y. D. (2019). Architectural Composition: A Systematic Method to Define a List of Visual Attributes. *Scientific Research Publishing*.
108. Shepheard, P. (1994). *What is architecture? : an essay on landscapes, buildings, and machines.* Cambridge: Cambridge, Mass. : MIT Press.
109. Siemas, L. R. (2013, October 10). *e-seimas.lrs.lt*. Retrieved from e-seimas.lrs.lt: https://e-seimas.lrs.lt/portal/legalActPrint/lt?jfwid=nz8qn8hu2&documentId=09dce1b073ab11e494a19da07b82f985&category=TAD
110. Sotirios D Kotsopoulos, G. C. (2014). The dynamic façade pattern grammar. *Environment and Planning B: Planning and Design 2014*, 690 – 716.
111. Spurr, D. (2012). 4 Figures of Ruin and Restoration: Ruskin and Viollet-le-Duc. In D. Spurr, *Architecture and modern literature* (pp. 142-161). Michigan: University of Michigan Press.
112. Tedeschi, A. (2014). *Alogorithms-aided design* . Italy: Le Penseur.
113. travelguide.michelin. (2019). *https://travelguide.michelin.com*. Retrieved from https://travelguide.michelin.com: https://travelguide.michelin.com/europe/france/franche-comte/doubs/arc-et-senans/royal-saltworks-arc-et-senans

114. Vallentine, A. (2002). *Architecture a very short introduction.* New York: Oxford University Press.
115. Vaughan, M. J. (2013). Representing architecture for fractal analysis: a framework for identifying significant lines. *Architectural Science Review*, 242-251.
116. Vitruvius. (1914). *The ten books on architecture.* Cambridge: Harvard University Press.
117. www.askostours.com. (2019). *www.askostours.com*. Retrieved from www.askostours.com.
118. www.khanacademy.org. (2019). *www.khanacademy.org*. Retrieved from https://www.khanacademy.org/humanities/renaissance-reformation/high-ren-florence-rome/bramante/v/donato-bramante-tempietto-rome.
119. Xintao Liu, B. J. (2012). Defining and Generating Axial Lines from Street Center Lines for better Understanding of Urban Morphologies. *International Journal of Geographical Information Science*, 1521-1532.
120. Yang Kuang, E. K. (2012). *Pre-Calculus For Dummies.* New Jersey: John Wiley & Sons , Inc.

Appendices

Appendix 1. Survey questionary

Building Aesthetics Survey

This survey is part of an academic research from the course of Master in Architecture from Kaunas University of Technology related to the thesis "Architectural patterns language and possibilities of its parametrization", the aim is to obtain information from visual perception of some iconic buildings and it has a duration of 5 minutes. For more information please contact: natanael.lopez@ktu.edu

*Required

General Questions

1. What is your age?

2. What is your gender?

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say
- ◯ Other: _____

3. What is your nationality?

4. What is your profession career? E.g. Architect, Engineer, Designer, etc

Building attraction

5. Choose the most appealing building for you? Choose one please *

Mark only one oval.

- Option 1
- Option 2
- Option 3

6. Choose the most appealing building for you? Choose one please *

Mark only one oval.

- Option 1
- Option 2
- Option 3

7. Choose the most appealing building for you? Choose one please *

Mark only one oval.

- Option 1
- Option 2
- Option 3

Aesthetic recognition

8. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

9. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

10. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

11. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

12. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

13. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion

Hierarchy

14. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

Rhythm

Contrast

Proportion

Hierarchy

15. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

16. Choose the most easy composition element that you can identify in the following picture. Choose one please. *

Mark only one oval.

- ◯ Rhythm
- ◯ Contrast
- ◯ Proportion
- ◯ Hierarchy

Aesthetic relevance

17. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

18. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

19. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

20. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

21. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

22. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

23. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

24. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
Contrast	◯	◯	◯	◯
Proportion	◯	◯	◯	◯
Hierarchy	◯	◯	◯	◯

25. Choose a score for each composition element that is more aesthetic relevant for you. Being 1 the less important and 4 the most important *

Mark only one oval per row.

	1	2	3	4
Rhythm	◯	◯	◯	◯
	◯	◯	◯	◯

Contrast				
Proportion				
Hierarchy				