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Original Research Article

Space Tectonics Role in Building Forms: Improving the Relationship between Buildings and Sites of Cultural Buildings 1978 - 2020*

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Abstract

Problem statement: Recent developments in construction have resulted in divergence and reduction in the effective communication of the relationship between form, space, site, and architecture, which in turn reduces the audience's experience and recognition of the inherent and actual concept of the building. Meanwhile, tectonics, as a long-standing technique, with a concept of poetic art can provide a solution for modern architecture which lacks feelings of architecture. Tectonic attitude can be defined as a factor, unifying space and form in relation to the site.

Research objectives: This study attempts to examine the relationship between space tectonics and the physical form of cultural buildings of contemporary architecture in Iran in the last four decades, via semantic measurement technics.

Research method: This study is descriptive-analytical using a mixed method. Theoretical foundations of research and field study were combined and sources, documents, as well as texts were examined using the library method. The main technique was measuring the connotative meaning associated with the concepts of contemporary cultural buildings in identical periods via the semantic differentiation scale. The appropriate pattern was extracted based on analysis and experts' opinions.

Conclusion: The main finding of the research implies that there is no significant linear relationship between space tectonics and physical form in any of the periods. The conceptual model components are explained such that a change in space tectonics does not lead to a change in the physical form of the building. Therefore, it can be concluded that the form of contemporary architecture in Iran is different from space tectonics even in the conceptual image of people.

Keywords: *Space tectonics, Form, Site, Cultural buildings.*

Introduction and Problem Statement

This article investigates the relationship between space tectonic and cultural building forms in the last

four decades in Iran. The factor necessitating this period investigated after Islamic Revolution is that the buildings were a product of the coordination

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of architecture, building systems, and components prior to this period. However, in a temporary period and in the period prior to it, i.e. after the scientific and industrial revolution, the unity of architecture, structure, and building components are challenged (Zarkesh, 2012, 24). Structure, space, and form architecture are inseparable constituents. The tendency for unity is the result of organizing factors. It can be such that the unity becomes evident at first sight and all other factors become sidelined or that the organizing factor is so complicated that the unity of the construction is hardly recognizable. In a complicated order, in cases where the components have an incomplete identity, the tendency towards unity is more powerful than in the case in which the components are complete. The more incomplete and independent a component is, the easier it is to integrate into a unity. Such a component is always inclined to evolve. Uncompleted components give up their independence for the benefit of the unity and are dissolved in it (Grutter, 1989, 550). Space tectonic is the unity factor. Tectonic outlook is one of the factors connecting space design to construction reality, which is essential for building architecture. The impressions of a person in a space are declarable from the expression of force in the form of space. The relationship between tectonic and space is not a sum or a linear equation, rather it is an experience. Tectonics conveys the expression of forces through form, structure, and materiality, all of which can be used to produce space. Afterward, this space expresses a feeling to the viewer (Narsey, 2013, 18). The main concern of this research is to find the relationship between the tectonics of space and form in contemporary cultural buildings of the last four decades as well as their association to the site. The main technique of comparing the meanings derived from contemporary cultural buildings in the same time intervals is the method of Semantic Differentiation¹. It seems that figuring out the mental image of the user of the building is one of the important and effective factors in the selection of effective and efficient methods so that the architectural value is preserved and appropriate feedback is consistent with the needs of the users of the building. Based on the components derived from the tectonic history of

the world's architecture and the theorists' viewpoint, two pairs of adjectives were extracted from literary texts in the research procedure. Since the bipolar attributes extracted from the theorists' approach were selected to improve the relationship between the building and the site; various tools can be used to influence the mental image of the users in the designing process. Tectonic attributes such as ordered, symbolic, static, identity, light, immaterial, structural, skeletal, shaped, open, clear, empty, vertical, external, continuous, and component attributes are included and considered the tools. Prominent cultural buildings' information in four-time intervals was collected in a library research method. A building was selected by the researcher and architecture experts² in an identical time interval. Standard questionnaires were separately prepared in Google Forms for each building to test the statistical population and were presented to the interviewee's in in-depth interviews. People selected were under-graduated or were of higher education. To declare the innovation and necessity of the research, it should be mentioned that the research method and tectonics consideration was mental image³ measurement and viewers' perceptions were assessed by authentic documents such as photos and videos. Furthermore, research hypotheses were assessed by semantic differentiation and evaluated by the correlation of tectonics of space and site. Cultural buildings were selected since cultural buildings' designers take different approaches to designing, the significance of appropriate relation between form, space, and site, and the interaction of each of the architectural elements. Raw data of statistical samples were analyzed by proper technics and SPSS v. 27.

Research Questions

- What is the proportion of space tectonics and forms of cultural buildings in the contemporary architecture of Iran?
- How the relationship between space tectonics and forms has changed over time in the contemporary architecture of Iran?

Research Hypotheses

Main hypothesis: space tectonics is a significant

and influencing factor in cultural buildings' form in contemporary architecture of Iran.

Sub hypothesis: the relationship between space tectonics and form has changed over time in the last four decades in the contemporary architecture of Iran.

Research Background

There is a growing body of research on architectural tectonics in the world. Cases related to this research topic are stated in general (Frasconi, 1984) considers tectonic details as the seat for innovation and invention in his article 'The Tell-the-Tale Detail'. Porphyrios (2002, 136) mentions that material, connection, and form stability are as visually the basis of tectonics. English architect and theorist, Neil Lehr, described computers as "an efficient search engine established based on the concept of efficiency" in his book entitled "History of Digital Art" (2004). Professor Angus MacDonald describes form tectonic in his viewpoint in one of the chapters of the book 'The Routledge Companion for Architecture Design and Practice' (MacDonald, 2004, 87). Semper divided construction products into light components (facade) and heavy elements (body). According to Semper, tectonics simultaneously deals with the structural, technical, administrative, and aesthetic layers of architecture. Based on his tectonic theory, the association of technical and administrative layers with art and aesthetics leads to the unity and coherence of the shell and the core (Liu & Lim, 2006). Hensel and Menges pointed to the biological and climatic influence of tectonics (2008). Kenneth Frampton explained that tectonics is the natural use of structure or materials (Katona, 2010). Sickler believed that tectonics is the return of art to the technical part of a building. He dealt with the structure and tectonics relations (Holst, Kierkegaard & Mullins, 2010). According to Butchers' description, it includes structural articulateness, a tendency for a lighter and more efficient structure, and the neat organization of utility (Wu & Fu, 2014). Schwartz defines interprets tectonics as the product of ideas that approves the multifaceted nature of tectonics in itself (2017). Gregory states that tectonics is hidden in the details or the action of details (Kassim, Majid, Sharif,

2018). Patrick Schumacher visualizes the fourfold process of spatial order, technical implementation, materialization, and coordination for the architectural design; of which coordination is a significant portion. Through expanding ideas and techniques, Zaha Hadid used the tectonic theory as a complicated method of architectural design (Hadid, 2010). Research on contemporary architecture in Iran has been carried out which is relevant to architectural tectonics. In his article 'Tectonic façade' in the Traditional House of Shiraz, Iran (case study: "Zinat-ul-Maluk House") Ekhlesi has evaluated the facade of traditional Iranian houses with a tectonic viewpoint (Ekhlesi & Rafati, 2015). A study on Iran's Mall architecture from a tectonic viewpoint, done by (Yadegari, 2.15) has focused on body configuration features. Tectonic is mostly dealt with as a theoretical foundation. Ruzbahani (2016) in "Sustainable tectonics: a conceptual model for evaluating the form structure in sustainable design" offers a conceptual model for the analysis and evaluation of sustainable architecture. Afshari, Kalharnia & Nouri (2021) researched qualitative analysis of the public buildings of contemporary architecture of Iran during the second Pahlavi period with an architectural tectonic approach (2020), and a tectonic reading of the public buildings of contemporary architecture of Iran in the first Pahlavi period, case study: Alborz High School, Museum of Ancient Iran, etc. (2021). In another article, Pourmohammadi, Maffakher, Saedsamii & Metin (2021) investigated the dual nature of tectonic relations in the contemporary architecture of Iran. Tectonic is a term used to describe an aspect of architecture that is manifested by construction or industry in its constructed form. There are many interpretations, including the art of connection, the boutique of structure and construction, and the ontological effects of the constructed form (Narsey, 2013). Tectonics is a word, originally from Greek, derived from the tekton, meaning carpenter or builder which in turn is derived from the Sanskrit takṣan, referring to carpentry and the use of an axe. Remnants of a similar term can be found in Vedic (Sanskrit) where it refers to carpentry. It is also found in Greek in Homer, where it refers to the art of construction in general. The

poetic connotation of the term first appears in Sappho where the tekton, the carpenter, assumes the role of the poet (Frampton, 1995). The term is used in a more aesthetic concept over time, which was quoted by Adolf Heinrich (Narsey, 2013). The term is also used in biology and geology nowadays, however, it is identified by its carpenter and builder background, in origin, words that were called tekton in Ancient Greek (Sekler, 1965, 89). By passing from physical and specific concepts, such as carpenter, to concept generalization, it is more revolved beside poetry. Tectonics idea is consciously revitalized in the nineteenth century. German thought is evident from all tautological definitions of this term in English, which are entirely related to building in a real sense. This term is suggested by an architectural scholar. In Kenneth Frampton's study of tectonic culture in architecture, this term was used by Müller, an architectural scientist pertaining to "a series of arts which form and make perfect dwellings and places of assembly...we call this class of artistic activities tectonics" (Frampton, 1995). According to library research on architectural theories, there is no agreement on the tectonic concept. This resulted in different viewpoints and disagreements. Thus, this research is more influenced by theoreticians, Gottfried Semper and Kenneth Frampton's approach. Based on the research on tectonics, it can be perceived as an outlook derived from the technological nature of architecture, or the poetic art and technique of creating space, that conducts architecture from construction to an integrated and purposeful phenomenon. An examination of the research background on architectural tectonics, reveals that no research has investigated people's mental image of space tectonics in the determination of cultural building forms. In other words, space tectonic relation with the form of the building was discussed considering the received meaning. Tectonic has a wide history in global architecture. It has received attention in recent years in the contemporary architecture of Iran. Therefore, this research is essential and effective in introducing the developments of today's architecture, employing the experiences in tectonicizing new architectural spaces, and in unifying it with the principles and theoretical foundations of Iranian architecture.

Research Method

There are two variables considered in this research, space tectonics and building form that is dependent on space tectonics. The research was done by comparing the received meaning of contemporary cultural buildings at the same time intervals. The semantic differential was the scale to measure research questions in this research. Afterward, by primary analysis of the field studies questionnaire as well as expert opinions, the optimal pattern was extracted. The strengths and weaknesses were examined and the results were resubmitted to the experts to be finally evaluated. A Survey technique was employed as the data collection method. The questionnaire is the common data collection tool in survey research. Experimental data were collected through the questionnaire in a project. The post-revolution period consists of 42 years 1979-2021; which we divided into six intervals of seven years. The prominent cultural buildings were determined and info-collected for every seven years, was collected using the library method. Space tectonics occurrence was explored. One prominent building was selected amongst all the cultural buildings for each of the intervals. The criteria were the occurrence of more tectonic features. Subsequently, the featured buildings were measured in terms of their relationship with the form variable. Hence, more than 100 architectural graduates and professors were given six different cultural building questionnaires. They included three information categories – 3 general, 16 space tectonics, and 5 building form questions. The Cochran sampling technique was used to sample and 389 respondents were selected as representative of the statistical population. Considering demographic information, the general information gathered from 380 questionnaires was initially examined for six various buildings. The first questionnaire consisted of 16 questions on space tectonics, which were designed by semantic differentiation. Bipolar adjectives were extracted from the theorists' attitudes to test the semantic difference. 16 bipolar adjectives were scored from 1 to 5. These variables were derived from thematic literature. The second questionnaire was related to physical form. It consisted of five questions: 1. Is the current building

form a function of observing spatial structure concepts? 2. Is the current building form a function of considering design coherence principles? 3. Do you think the building and construction shape has affected its form? 4. Has the building material affected its form in your opinion? 5. Is designing background considerations visible in this building? Items were assessed on a five-point Likert scale. Points were assigned from 1 for a less degree to 5 for a greater degree for each criterion. 65 Ph.D., graduate, and undergraduate students and teachers of architecture participated in the survey. Prior to print, the questionnaires were assessed by the tectonic experts, in order to measure their validity. Final adjustments were made. Despite this, internal reliability was measured by Cronbach's Alpha. Cronbach's Alpha indicates how closely related a set of questions stands as a group. High Cronbach's Alpha for all variables of the questionnaire is not possible. This research measured variables such as space tectonics and building form. Most spaces are ordered but are of less or more detail. Thus, Cronbach's Alpha is a good point in case the responses are correlated. However, space tectonics is considered a complex variable, and Cronbach's Alpha is not usually needed to be measured for complex components. As each adjective measures, a particular constituent, the concept can be without any correlation. Thematic literature was closely reviewed to extract theory variables. Afterward, the criteria for each variable were determined. Defining variables and setting criteria are of high importance for hypothesis testing in this research. Each of the theories was qualitatively and quantitatively tested with these criteria and the strength and weaknesses of each theory were evaluated. Descriptive-analytical methods as well as inferential statistics were employed to analyze the data collected. Data collected are presented in frequency distribution tables and statistical parameters. Subsequently, the relations are analyzed by multivariate Regression and Correlation. The researcher seeks to understand the relationships among variables in the Correlation research method. In Correlation studies, independent variables are not manipulated by the researchers, rather, the variables are measured and it is determined if there

is any correlation among variables. As variables are not manipulated or changed in correlation studies, the subjects are not randomly assigned to different groups that are formed based on the dependent variable (Sarmad, Bazarghan, & Hejazi, 2022). Multivariate regression is an analyzing tool and is employed to explain the strength of the variables' relation in correlation studies (Groat & Wang, 2011, 238). Friedman test was used to test research variables. There are six buildings, thus six different measures are evaluated. Participants gave six points for six buildings. As there have to be seven points to score, research data was not considered quantitative. Therefore, instead of the Analysis of Variance test, the Multivariate non-parametric Friedman test was selected to assess the correlation. Raw statistical sample data were analyzed with the proper statistical technique. The research hypotheses indicate that there is no linear relationship between variables of space tectonics and cultural building forms of contemporary architecture in Iran.

Theoretical Foundations

• Architecture in the Islamic Republic period

The architecture of the Islamic Republic period can be divided into two distinct periods. The first period begins in September 1980 revolution until the end of the Iran-Iraq war, which ended in August 1988. The second period comprises the stabilization and reconstruction of the country, starting from the end of the war to the present time (Ghobadian, 2014, 295). The imposed war overshadowed the country's architecture for years, and the post-war period was so busy with mass construction and satisfying immediate needs that little attention was paid to the nature of architecture. Subsequent years especially from 1992 onwards, witnessed gradual attention to architecture. However, this period was concurrent with postmodern currents in the West. Accordingly, instead of creating a postmodern space, postmodernism was copied (Kamelnia & Mahdavinejad, 2012, 235). Qobadian divides the post-revolution architectural trends into two periods: the first period is from 1978 to 1988 and includes 1. Traditional architecture and Traditionalism

2. Late modern architecture including international style
 3. Post-modern architecture includes the neo-Gajar style and localism style. The second period is from 1988 to 2012 and includes 1. Traditionalist architecture 2. Late modern architecture (International style, Architectural sculpture style, Minimalism style) 3. Post-modern architecture (Modernist style, Localism style) 4. High-tech architecture 5. Green architecture (Bioclimatic architecture, Sustainable architecture) 6. Deconstruction architecture 7. Folding architecture (Fig.1).

• Theorists’ Viewpoint on Bipolar Adjectives’ Extraction

Part: Theorist Bötticher proposed the idea of part and whole. The essence of details is what is emphasized by Gregotti (Frascari, 1984). Continuous: Frampton believes that architecture is a logical and integrated construction method in interaction with the site (Bolboli, 2018).

- Enclosed

the boundary of in-outside is critical to recognize the spatial functions of structures on the level of macro

tectonic. Bejder states that three building configuration is defined by slabs and palates. They range from enclosed boxes to floating structures (2012). Walls are differently contacted with the outer boundaries of the buildings in each configuration (Yordanova, 2019).

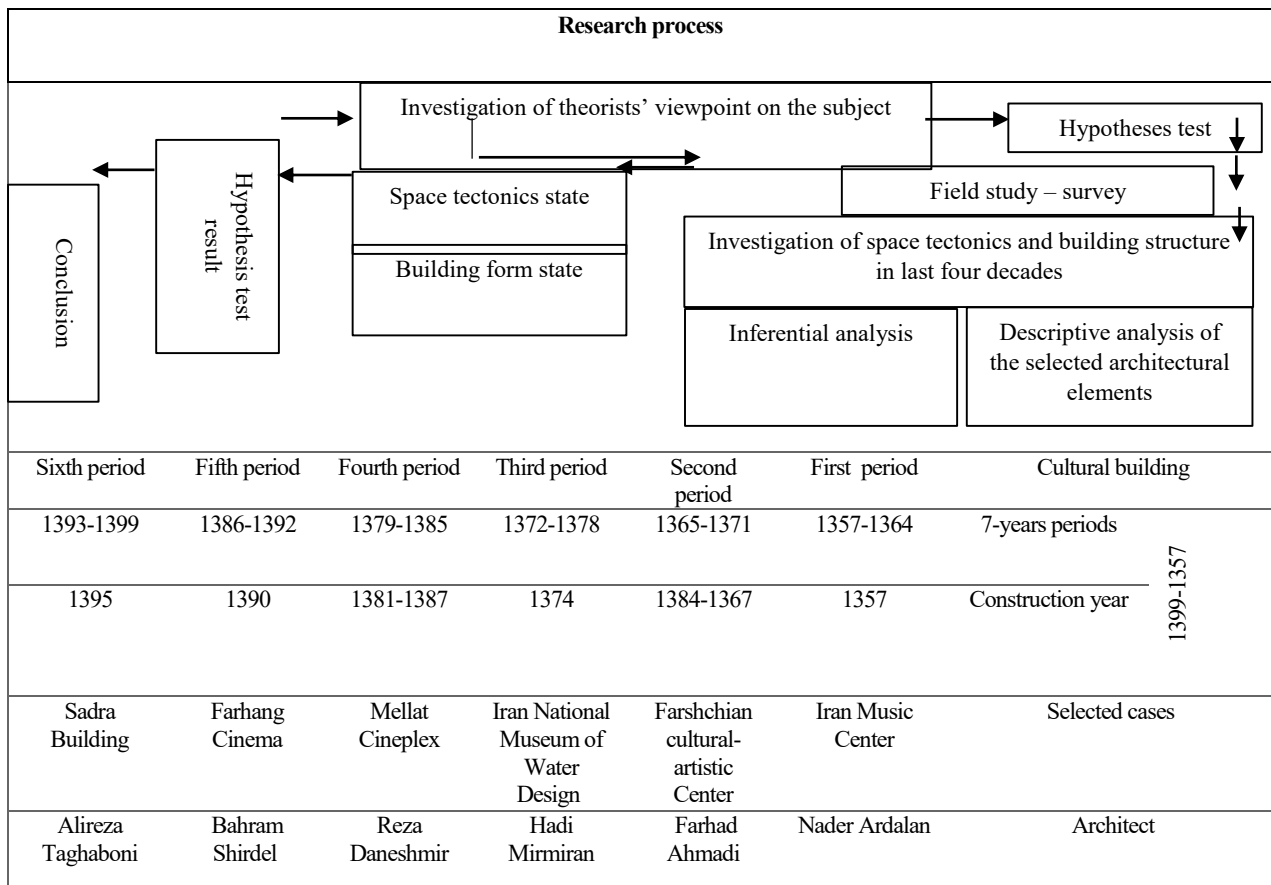
- Empty

Semper’s term Tektonic is summarized by Stanford Anderson University as “constructs of articulated elements (elastic skeletal structures, e.g., timber or metal frames)” and the term Stereotomic is defined as “comparatively inert assemblies (intractable masses, e.g., masonry walls).”

- Immateriality

While Bötticher’s tectonics is related to the ontology and the representation of the spatial structure, Semper’s tectonics suggests a materially spatial approach, the object of which was a high level of spatial effect, beyond simply material techniques. According to Semper’s view, and expanded as it was by Frampton and Guisado, his tectonics may be defined as knowledge dealing with the

Fig. 1 Research process. Source: authors.



spatial construct composed of clearly jointed framing components clad or infilled with lightweight material compared with stereotomics, which is concerned with a monolithic construct with the massive continuum of solid material. In contrast, in cases where materials were not constructed in a logical way following their characteristics, or when they pretended to be another kind of material, people have predictably considered it as the manifestation of atectonics.

- Vertical

Frampton explains and states the ontological differences between the two terms. He asserts that the tectonics of the frame is light and inclined toward the sky; however, the stereotomic mass is heavy and tends to embed itself deeper toward the earth. The relationship between the building and the earth is as important as its presence on the earth. This expression of the relation between the sky and the earth creates heaviness and lightness for the human being to experience: it is tectonics (Narsey, 2013).

- Light

Another way to manage the difficult-to-master space-separating function of plates is light. Carlo Scarpa used light to create space over the walls behind the white gypsum casts in the Gipsoteca Canova. Space comes into existence where there is light. The role of the secondary non-loadbearing elements in slabs and plate structures generally involves decreasing their dominating space-separation function. These elements are windows, doors, and glass walls. Although most of the windows have plates in their structures, these plates are transparent and the light that passes through them makes them space-transforming components (Yordanova, 2019).

- Open

Semper considers the tectonic wall as a combined type, that is, the frame with the filling, which Frampton, in modern words, referred to as the framework and the lightweight enclosing membrane, respectively. Although Semper's theory on original tectonics was founded on carpentry as the frame or the support, the spatially enclosing function was more central than the structurally supporting one in Semper's tectonic wall (Kim, 2006, 17-26). This research puts less emphasis on walls and aims

at decreasing masses and increasing vacuums. Skeletal: Semper divided the building construction method into two essential methods: Frames' tectonics when they are lightweight, their components combination is linear and consists of a spatial matrix that is the boundary of the place where mass and volume are formed between the repetitive columns between the lightweight elements. Based on the pragmatic anthropological taxonomy of Semper, Kenneth Frampton explained tectonics and stereotomics as follows: "the tectonics of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the stereotomics of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements" (Frampton, 1995).

- Ordered

Theorist, Eduard Franz Sekler emphasized three aspects of tectonic structure and construction. He believes that structure consists of material selection, techniques, ordering, and efficiency in a building, nevertheless, construction is defined as the particular physical appearance of a structure which is done by building forces (Bolboli, 2018).

- Symbolic

Frampton gave the term "Tectonics" an artistic aspect and described it as a "poetic poem of construction". He considered Tectonics as a culture imposing itself as one of the chief solutions against the viewpoint of cultural erosion and architectural commodification that prevailed in the 19th century. Considering three principles of Vitruvius, Semper suggested a theory based on which the architecture of a hut consists of two parts. A part is related to frame structure and its relation to the context and ontology, society, religion, politics, and climate. The other part is related to components and elements of the area and inside the building that are mostly symbolic and artistic (ibid.).

- Static

Although Anderson identified the term tectonic with the concept of technical form, Anne-Marie Sankovitch assumed it as related to mechanical statics distant from subjective sensibility: "the tectonic principle by which load, support, and thrust are accommodated"

(Sankovitch, 1998). Sankovitch regarded the concept of structure as more comprehensive than that of tectonic and argued that “structure includes the system of statics indicated by the more strictly tectonic meaning of the word, and it also encompasses the building’s ornament” (ibid.).

- Structure

Structure is a concept, a part, or a means of power transmission. The structure is a chief variable that can influence tectonic architecture. This points to the importance of structure even at the concept level, such that can place architecture on a poetic level (Sekler, 1965; Valhonrat, 1988).

- Identity

Kenneth Frampton has extracted tectonics from its several roots in etymology, topography, metaphor, ethnography, technology, and representation, as well as ontology. He presented tectonic features not only in technological approaches but in cultural and traditional aspects. Angus MacDonald defines tectonics as determining the form based on the structural requirements of the combination of art and science in architecture; an issue of construction and environmental considerations.

- Lightweight

Semper presents the definition of tectonics based on its etymology, system, and material construct. The concept of tectonic is common in the three categories of “Art, Framing, and Construction” in which linear elements are connected to joints and are filled or covered with lightweight materials (Soo Kim, 2006, 17-26).

- Form

Bötticher recommended two elements of tektonik, core form (kernform or work form) and art form (kunstform) as the essential issues of tectonics. Thus, Bötticher defines tectonics of a building as the core form and art form (ibid.).

• Tectonic criteria in the analysis of selected buildings of contemporary architecture 1979-2020

- Building skeleton: the study of the primary materials of a building.
- Tectonics and Stereotomic4: the study of the materiality

of the constructed environment so as to improve the building and site connection.

- Details + Section: they make the smallest scale of an architectural piece.
- Place: the study of the influence of a place on the tectonic arrangement of a building.
- Space: the study of the relationship between space and construction characteristics related to the site.
- Atectonics: the study of settings that are in contrast to the general ideas of tectonics (Fig. 2).

Findings

Once the research methodology was introduced and discussed, the results and findings of field and library studies are stated. To statistically evaluate the theoretical concepts of this research, the concepts were evaluated based on the variables and indicators that were derived from the questionnaires. Friedman test was used to statistically examine the hypotheses. The criteria to judge the hypotheses are respectively: 1. F. test, which indicates how significant the regression analysis is in general, 2. R. correlation coefficient, which shows what percentage of changes of the dependent variable is due to independent variables. One coefficient shows a change in the dependent variable per unit of change in the independent variable. General information from 380 questionnaires was assessed in the demographic information section.

• Demographic Descriptive Statistics and Main General Research Variables

Subjects’ appearance or demographic features is one of the best ways to understand and recognize the respondents. Gender, age, and education level of respondents are data, collected and presented in table and graph. Gender is the first demographic characteristic discussed, in which the highest frequency of the studied sample is women – N= 46 (70.8%). Men were 19 people (29.2%). The highest age group was between 30- 35 y. o. (N=18, 27.7%) and the lowest frequency occurs in the age group of 20- 25 y. o. (N=6, 9.2%). The highest frequency of education degrees belongs to graduates (N=33, 50.8%), while the lowest frequency is for Ph. D. graduates (N=14, 21.5%). Afterward, 65

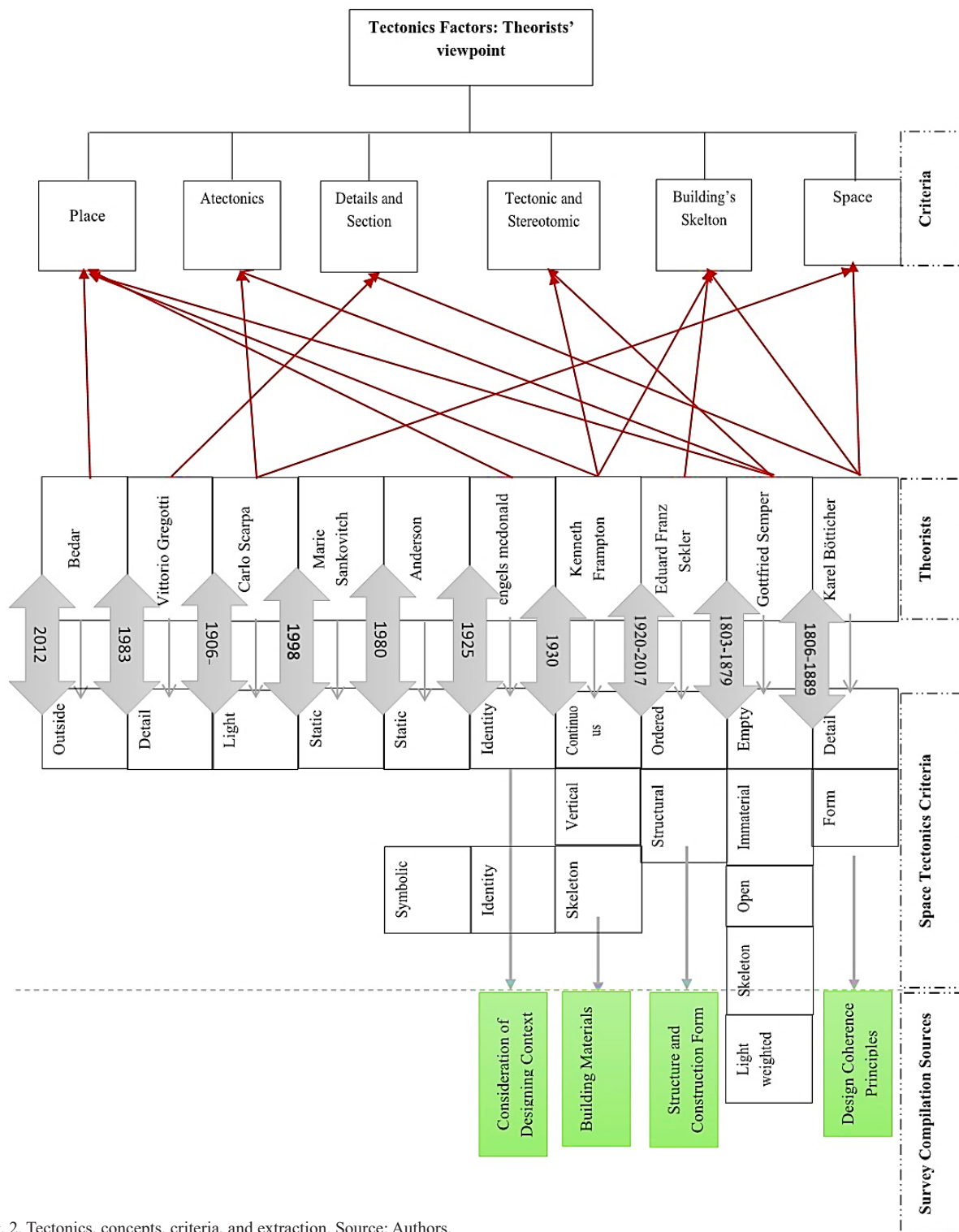


Fig. 2. Tectonics, concepts, criteria, and extraction. Source: Authors.

responses on 6 selected building samples were examined in this research. The results of rate selection for 16 tectonics-measuring features and 16 non-tectonics-measuring features are presented as percentages in the following table. The questions of the Iran Music Center

building form are then examined. Five questions are taken into account to assess building form - spatial structure, principles of design coherence, structure and construction shape, building materials, and design context considerations. The frequency and selection

Table 1. Pearson correlation coefficient test results between space tectonics and physical form variables. Source: Authors.

Buildings	Pearson Correlation Coefficient	sig
Building 1	-0.053	0.688
Building 2	0.050	0.710
Building 3	-0.208	0.123
Building 4	0.106	0.443
Building 5	0.035	0.793
Building 6	0.051	0.704

Table 2. Multivariate regression test. Source: Authors.

Building	Durbin Watson Test	Significance Level	F Statistic	Adjusted R Squared	R squared	Correlation Coefficient	Test Result
Building 1	1.635	0.809	0.666	-0.106	0.210	0.459	The Model Is Not Significant
Building 2	1.795	0.543	0.931	-0.020	0.271	0.521	The Model Is Not Significant
Building 3	1.973	0.137	1.542	0.141	0.400	0.632	The Model Is Not Significant
Building 4	1.767	0.903	0.546	-0.156	0.187	0.432	The Model Is Not Significant
Building 5	2.080	0.175	1.429	0.106	0.352	0.594	The Model Is Not Significant
Building 6	1.640	0.375	1.113	0.030	0.298	0.546	The Model Is Not Significant

percentage of each option were also examined in 5 other selected building samples. 65 questionnaires are offered in total. Based on the results, the Iran Music Center building clearly shows tectonic features such as ordered, symbolic, static, identity, open and continuous features. According to responses about the building form of the Iran Music Center, more than 70% of the study sample agree or strongly agree with the spatial structure, design coherence principles, structure and construction shape, building materials, and design context considerations. The cultural-Artistic Center of Farshchian building displays tectonic features such as ordered, static, identified, open, clear, continuous, and component features. It is evident from the Cultural-Artistic Center of Farshchian building responses that more than 65% of the sample agreed or strongly agreed with the spatial structure, design coherence principles, structure and construction shape, building materials, and design context considerations. The National Water Museum of Iran’s building clearly displays tectonic features such as ordered, symbolic, static, identified, structural, formed, skeletal, open, light, immaterial, and continuous features. More than 70% of the study sample agreed or strongly agreed

with the spatial structure, design coherence principles, structure and construction shape, building materials, and design context considerations of the National Water Museum of Iran’s building. Mellat Cineplex building displays tectonic features such as ordered, static, structural, formed, lightweight, skeletal, open, light, immaterial, empty, outdoor, and continuous features. More than 70% 67% of the study sample agree or strongly agree with the spatial structure, design coherence principles, structure and construction shape, building materials, and design context considerations of Mellat Cineplex. Sadra building displays tectonic features such as ordered, static, identified, structural, formed, lightweight, open, light, empty, outdoor, and continuous features. It is evident that more than 57% of the study sample agree or strongly agree with the spatial structure, design coherence principles, structure and construction shape, building materials, and design context considerations of Sadra building.

• **Variables correlation**

Pearson correlation coefficient was used as the test statistics to measure the relationship between space tectonics and physical form. Null hypothesis: there is no relationship between space tectonics and physical form.

Alternative hypothesis: there is a significant relationship between space tectonics and physical form. In the evaluation of the relationship between space tectonics criteria and physical form criteria, the normal distribution is not measured since the measurement scale is ordinal. Pearson correlation coefficient followed by multivariate regression tests is used to measure the relationship between the two of them (Table 1).

In the Pearson correlation coefficient, a null hypothesis indicates a lack of a linear relation. In case the significance level is less than 0.05, the null hypothesis is rejected and specifies a linear significant relation. Hence, there is no linear significant relation between space tectonics and physical form in none any of the buildings. This necessarily means that changes in one variable do not result in a change in another variable. The conceptual model of the research is explained such that a change in the space tectonics does not result in a change in the physical form of the architecture -- it should be noted that considering the small number of subjects, a high value is needed to get a significant correlation coefficient. This may influence test results. Once the relationship of variables was determined, the simultaneous effect of space tectonics' dimensions on the physical form was studied with a multivariate regression test and presented below (Table 2):

As the significance level of each six models is more than 0.05, it is concluded that none of the models is significant.

• Physical form and space tectonics trends and changes over time

Since six time periods were examined in this study, Friedman test was used to measure the variables in every six periods. Table 2 shows that the significance levels of all space tectonics are less than 0.05. Hence, it can be concluded that views are different in different periods, regarding these variables. The following table presents the rankings in different periods. Based on Table 3, the lowest mean and rank of ordered criteria belongs to the fourth period – i.e. reveals the best state regarding the order. Each period's ranking is presented in the table, green represents the best and orange represents the worst state.

• Physical form changes based on time periods

Friedman test was used to compare physical form

variables in the six time periods studied. The results in the Table imply that the significance levels of design coherence principles, design context considerations, and spatial structure are less than 0.05. Hence, it can be inferred that the viewpoints regarding the variables have transformed. The following table presents the rankings of different periods (Table 4).

Conclusion

This study aimed to investigate the role of space tectonics in deciding the form of cultural buildings in Contemporary Architecture of Iran, as well as to improve the relation of building and site by an analytic-descriptive approach, by library research besides field study survey distribution, and by SPSS v. 27. Subsequently, the research findings are presented as follows:

Less consistency with tectonic dimensions is evident in the traditional architectural form of the buildings of Nader Ardalan Music Center and Farshchian Cultural-Artistic Center (first and second periods).

Based on the research results, tectonic features of the architecture evolved from the first to the sixth period. Thus, Mellat Cineplex, Farhang Cinema, and Sadra buildings enjoy more architectural tectonic features.

Mellat Cineplex is relatively more consistent with tectonic features. The relationship between space tectonics and building form was studied since theorists stated that tectonic and building form variables should be consistent to improve the relationship between building and site. Consequently, building forms that complied with the principles of design coherence and followed the concepts of spatial structure and the design context based on Iranian theoretical principles and foundations were selected. They should also have considered limiting issues of structure, construction, and site as well as main architectural factors according to global technological needs. However, the analysis and tables indicate that the building forms designed and built in the most accordance with the theoretical foundations of Iranian architecture are not at a high space-tectonic level. Buildings with a high tectonic ranking are those with less ranking of form and vice versa. To interpret the findings of the research, it should be noted that tectonics,

Table 3. Space tectonics ranking based on period. Source: Authors.

		<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">Best to Worst Ranking</div> <div style="text-align: center;"></div> <div style="text-align: center;"></div> <div style="text-align: center;"></div> <div style="text-align: center;"></div> <div style="text-align: center;"></div> <div style="text-align: center;"></div> </div>					
	Period	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Ordered	Mean	2.53	1.61	1.89	1.53	1.75	1.71
	Ranking						
Symbolic	Mean	2.52	3.33	2.11	1.67	1.58	3.17
	Ranking						
Static	Mean	2.25	2.09	1.93	1.31	2.12	2.27
	Ranking						
Identified	Mean	2.07	1.93	2.13	3.00	2.14	1.54
	Ranking						
Structural	Mean	3.32	2.19	2.54	1.31	3.54	2.73
	Ranking						
Formed	Mean	3.44	3.74	2.14	1.38	1.97	2.07
	Ranking						
Light Weight	Mean	4.43	3.37	2.73	1.96	4.25	2.80
	Ranking						
Skeletal	Mean	4.37	3.37	2.52	1.42	4.34	3.80
	Ranking						
Open	Mean	3.98	3.93	2.77	1.38	2.95	2.14
	Ranking						
Light	Mean	3.80	2.32	2.68	1.05	2.05	2.10
	Ranking						
Vertical	Mean	3.95	4.68	4.78	3.56	1.44	2.51
	Ranking						
Immaterial	Mean	4.41	4.09	3.02	1.91	3.85	3.97
	Ranking						

Rest of table3.

		Best to Worst Ranking					
		1	2	3	4	5	6
Empty	Mean	4.15	2.91	2.98	2.75	2.32	1.78
	Ranking	6	4	5	3	2	1
outside	Mean	4.13	4.61	3.09	1.55	2.10	2.14
	Ranking	5	6	4	1	2	3
Continuous	Mean	1.62	2.25	2.29	1.31	1.81	1.54
	Ranking	3	5	6	1	4	2
Part	Mean	4.37	2.39	1.91	1.47	4.14	4.29
	Ranking	6	3	2	1	4	5

Table 4. Rankings of physical form factors in the periods. Source: Authors.

		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Spatial Structure	Mean	4.22	4.18	4.39	4.25	4.34	4.54
	Ranking	2	1	5	3	4	6
Design Coherence Principles	Mean	4.12	3.72	4.25	4.22	4.24	4.24
	Ranking	2	1	6	3	5	5
Design Context Considerations	Mean	3.62	4.12	3.75	3.78	3.85	4.37
	Ranking	1	5	2	3	4	6

with a poetic and artistic concept, considers a structure united with building stability, beauty, culture, and building materials. Thus, architectural tectonics includes skeleton, details, environment, Stereotomic, atectonic, and space, determining the form with the concepts of spatial structure, plan coherence principles, and design context of theoretical foundations of Iranian architecture.

Results indicate that space tectonics has the most and the least role in determining the cultural building form of Mellat Cineplex and Nader Ardalan Music Center, respectively. Such that in Mellat Cineplex, the structure is the organizer of the architectural space, and plays an important role in form determination. Despite this, it

actively transmits emotional forces and induces visual stability. Furthermore, proper materials are used in the shell and there is a complete match in micro and macro articulation aspects. The building is in good harmony with the surrounding environment and has created an urban symbol. The shell made of light weighted and transparent material glass induces a feeling of transparency and light, providing a pleasant visual connection between the inside and outside of the façade, making the building shaped with the environment. It can be stated that Mellat Cineplex is one of the contemporary tectonic buildings, which has created a poetic space and is well implemented. From among the assessed buildings of the first period,

Nader Ardalan Music Center results indicate that there is no acceptable compliance of the relation of the shell and structure with architectural tectonics. It seems that despite developments in general building structure, most architects have partially focused on the relationship

between the building and the site. However, this has led to a superficial resemblance between the buildings and traditional architecture of Iran, and tectonic features are not properly considered. The results of buildings in the six periods are provided in detail in Table 5. The main

Table 5. Final results of the research. Source: authors.

Selected Buildings name	Tectonic Variables	Theorists' Viewpoint Extraction	A rchitectural Period of 1978- 2020					
			Music Center	Farshchian Cultural Center	National Water Museum	Mellat Cineplex	Farhanf Cinema	Sadra Building
Space Tectonics	Detailed	Articulation of details and the structure is appropriate	×	*	**	***	×	×
	Open	The relation with the site is proper	*	×	×	***	×	**
	Outdoor	There are various contacts with outside	×	×	×	***	**	*
	Empty	Emptiness is felt more than masses	×	×	×	*	**	***
	Immaterial	Materials are transparent	×	×	**	***	*	×
	Vertical	It is extended to the sky	×	×	×	*	***	**
	Light	Materials provide light of the space	×	×	×	***	**	*
	Continuous	There is a relationship between inside and outside	×	×	*	***	×	*
	ordered	The materials of the structure and shell are appropriate	×	**	×	***	×	**
	Symbolic	There is a symbolic and artistic aspect	×	×	*	**	***	×
	Static	Structural forces are sensed	×	*	**	***	×	×
	Identified	A significant relationship exists with the environment	*	**	×	×	×	***
	Structural	The structure has a role in space organization	×	**	*	***	×	×
	Formed	The structure has a role in form determination	×	×	×	***	**	*
	Skeletal	The structure has a skeleton	×	*	**	***	×	×
Light weighted	It is filled with light weighted materials	×	×	**	***	×	*	
Physical form	Form conforms with spatial structure concepts	**	***	×	*	×	×	
	Form follows design coherence principles	**	***	×	*	×	×	
	Form conforms with the design context	***	×	**	*	×	×	

hypothesis of the research showed that the correlation between space tectonics and physical form is not significant. However, the sub-hypothesis of the research space tectonics has been gradually considered in various periods post-Islamic revolution. This is in a reverse trend with space tectonics. This in turn contradicts research hypotheses and leads to the rejection of main and sub-hypotheses. This research seems to clarify the gap between architectural form and tectonic spaces. The space tectonics approach can be considered as a form-generating element in future works to improve and expand architectural spaces' quality and to align with the site. Tectonics is introduced in this research as a new concept that is compatible with Gottfried Semper's viewpoint that building is divided into tectonic and stereotomic construction methods. Architecture is form expression via volume, which in designing open spaces, dematerialization, reduction of masses, and increase of voids leads to the lightness of the frame, and the diminution of the wall's role. It also leads to highlighting the importance of beams and columns and decreasing the limits of structural requirements. This in turn might result in fading the variation of inside and outside of the building. It increases the connection with nature and creates a transparent space with the least volume of materials. From this point of view, the building is no longer considered a symbol rather it is a volume in which materials and masses need to be formed in its site so that it evolves from a physical to a metaphysical world. Consequently, the combination of form and its contents makes a powerful space in case it owns a poetic construction and penetrates the existential nature of the audience. In contemporary architecture theories, the novel tectonic theories seek to offer approaches in which the artistic aspect of construction is considered as the main purpose. For instance, famous theorists such as Karl Böttcher despite considering integrated generalities of architecture proposes splitting architecture into main and artistic form and considering their relation to harmonize structure and construction. Based on current theories, this issue not only brings us closer to architectural tectonics but also to architectural elements and details that can be creatively employed in it.

Endnotes

1. Semantic Differential Scale is a quantitative method to semantically measure concepts in people, and describes the reaction of people towards a concept or object. The Semantic Discrimination Scale was invented in the 1950s to indirectly measure one's feelings toward concepts, objects, and other people. It measures people's feelings about things by adjectives since people assess based on oral or written adjectives. Adjectives are usually bipolar – e.g. dark and light, hard and soft, slow and quick. The semantic differentiation scale understands what is evaluated and is an indirect measurement tool.
2. Experts are professionals who are knowledgeable, experienced, willing to participate, and have time to participate, based on the Delphi method. Architecture students, undergraduates, and more were participants in this research.
3. Mental image is the rebuilding of the physical world in a human being's mind. This mostly involves experiencing an object, event, or scene that cannot be sensed in reality. The mental image might sometimes have the same effect as the actual experience.
4. Stereotomy: Craft of cutting and dressing complicated blocks of masonry such as those for an arch, vault, or spiral staircase.

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