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EXAMINING SPACE TRANSFORMATION IN APARTMENT-BASED HOUSING UNITS IN ISTANBUL USING SPACE SYNTAX PARAMETERS

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Abstract

Housing units can emerge and also reflect the structure of space organizations as well as social organizations of various scales. This structure is mainly related with when and where they are built, as well as in which social and physical structure they exist.

This paper aims to examine and define the relation of the changes in Istanbul apartments' spaces in terms of space syntax parameters through the time period 1930-1980. The change, development and specialization of the living spaces in Istanbul's apartments by time, related with the changing technology that is used inside building spaces and building mechanical systems. The transforming social structure of the society is also the key to examine and analyze the syntactic parameters. Although syntactic parameters are important to analyze the changes related with various turning points in building technology affecting interior and exterior design of buildings, semantic parameters and the behavioral acts of the people living in these houses has to be considered in order to indicate the relations with transformation and space syntax. Changes in the perception of apartments' living spaces by their users with the affect of the technological changes such as the contribution of mechanical heating systems and the TV to the buildings' spaces; building construction regulations are also turning points in the change of spaces. The results of the syntactic analysis made in different types of spaces of various time periods will examine the transformation and development in terms of syntactic parameters of apartments' spaces, but the most important part of the analysis is the affect of building construction regulations, which have changed several times since 1930s in Istanbul, on the transforming morphology of apartment-housing units' spaces. This research aims to provide an understanding of this phenomenon. Analysis will be made through apartment units' plans by syntactic methods of spatial analysis and these analyses should also be evaluated with the semantic values of spaces. The research concentrated on the architecture of apartment buildings built between 1930s and 1980s will try to explore the spatial properties and transformations of the apartments with several examples from different periods in the specified timeline. The results of the case study in apartments' living spaces will be converted to numerical database in order to be analyzed by "University of Michigan" licensed "Syntax2D" software. In this sense, convex space integration analysis with the isovist integration, space partition analysis and visual field analysis are important.

Briefly, this paper scrutinizes the relation of transformation in living spaces of Istanbul's apartment based housing units with the change in building construction regulations, and technological inputs of exterior and interior design of apartments by using the syntactic design parameters and analysis.

Keywords: *Space syntax, Turkish domestic space, Istanbul apartment morphology, Syntax 2D, spatial transformations, Housing*

Theme: *Building Morphology and Performativity*

1. Introduction

This paper examines and defines the transformation of Istanbul apartment spaces during the period from the 1930s to the 1980s in terms of space syntax parameters. A diachronic investigation of living spaces in Istanbul apartments is carried out in this research. The transformation of the social structure of society and regulation of buildings serve as key concepts together with an examination and analysis of syntactic parameters. Although syntactic parameters are important in analyzing changes related to various turning points in building technology that affect interior and exterior designs, semantic parameters must be considered to indicate the relationships between transformation and space syntax.

Changes in perception of apartment living spaces according to their users together with the effects of technological changes, i.e., the contribution of mechanical heating systems and TV to building spaces, and building construction regulations are defined as turning points in this context. In brief, the objective of this work is to investigate the transformation of the domestic spaces of Istanbul's apartment-based housing units together with the changes in building construction regulations and the technological inputs into the exterior and interior design of apartments. Syntactic design parameters and analysis are applied in this context.

2. Social Structure of Space and Space-Syntax-based Theories in Transformation of Housing Units' Spaces

Cultural identity and semantics are concepts built on the circumstances of function and significance within the context of space syntax theories. Function and space allocation in buildings is also an important aspect of culture with respect to spatial transformation of apartment plans.

The creation of vacant spatial volumes and transformation of their layouts from the state of a physical object to a textural dimension is important. The purpose of buildings is to put space in order and to enable its consideration together with an order concept for approximate spaces (Hillier and Hanson, 1984) (Hanson, 1994) (Hillier, 1996) (Hanson, 2003). Syntactical analysis is related to space order and is conducted using several parameters that will be addressed in detail later in this study to demonstrate the spatial transformation of plans. The relationship between environmental behavior and space syntax theories is a key to this study but is also a concept that should be investigated beyond this research.

Organization of inter-spatial relationships and their hierarchy is associated with order and hierarchy that mirror the relationships of people in which society intervenes in the form and basic nature of buildings. In this context, buildings are important visual symbols of society (Hillier and Hanson, 1984).

Privacy, territoriality and defensible space theories that address the defense of a given area or a pattern of behavior that defines and defends a spatial territory as a distinct expression of social reality have affected architecture at many stages, i.e., understanding, designing and altering the space. In Altman's (1975) style of approach, privacy emerges as an organizing mechanism that designates interpersonal interaction. Proshansky, Ittelson and Rivlin (Proshansky et al., 1970; Proshansky et al., 1976) stated that privacy increases freedom to a high level in choices associated with behavior. In that sense, relationships are important to understanding the transformation of apartment plans in Istanbul as a function of time, and privacy is crucial in these changes.

The tendency for individuals to act on designated instincts for claiming and defending an explicitly marked space are emphasized in Oscar Newman's (1972) defensible space theory. This approach,

which can be addressed for cognition-based theories, is not sufficient to form a foundation for the social logic of space (Hillier and Hanson, 1984), but Kaplan's (1987) studies represented a milestone in terms of understanding the relationship between cognition-based theories and the physical environment. Kaplan (1987) reported findings aimed at the possibility of a low-awareness-level type of cognitive state in which we think quickly to affect our assessments of space by obviating our judgments. This situation reveals the place of the perception/cognition/physical environment relationship in structuring, defining and developing that environment.

Buildings express social meaning by their appearance and in their plans. Space syntax theory attempts to demonstrate this social relationship by treating the association of space with its physical relationships (Hillier and Hanson, 1984). In "The Man-Environment Paradigm and Its Paradoxes", Hillier and Leaman (1973) discussed that the artifactual physical world already acts as social behavior together with its grip on spatial organization.

In space syntax research, it is sometimes claimed that individuals' "use of space" and "motivations" do not reside in the space concept. According to Penn (Penn, 2003), the motivations of individuals and clues to the essence of their cognitive states may already exist in space syntax theory itself and its analyses, and thus, the theory and analyses may contribute to a better understanding of individual-level mechanisms by excluding these items. In space syntax theory as a social theory, this state of exclusion is a method to better understand these mechanisms.

In conclusion, by representing a structure in the context of form, space syntax theory is fundamental to the social structure of space and contributes to understanding of space together with its many physical and semantic parameters according to the concepts it reveals. This approach provides a strong, systematic and basic analytical relationship by enabling analysis of the changes in space with time. Types of space that are different in terms of location and time can be examined in the same quantitative framework via these analyses.

3. Previous Studies on Domestic Space Investigations related to Space Transformation in Apartment-based Housing Units in Istanbul

Turkish domestic space was previously researched by Guney (2005) in a work that focused on the visibility structures of nineteenth century spaces and used a number of tools. This researcher used a space syntax methodology to uncover the underlying genotype and its transformation over time by analyzing houses in Ankara throughout different periods. "Transition-space-centered organization" (Guney and Wineman, 2008) was reported as the spatial structure. "The control of permeability and visibility that serves the need for privacy to regulate interpersonal interactions" (Guney, 2007) was a key concept based on permeability analysis, in which a longitudinal series of house plans are grouped into three genotypes: houses of the 1920s with no sector differentiation and one entrance, houses of the 1930s-1960s with different sectors and multiple entrances, and houses of the 1970s-1990s with different sectors and a single entrance (Guney and Wineman, 2008). This analysis showed that spatially and visually, the most integrated spaces coincided with each other for all three groups. "The findings of the research indicate that visibility analyses is more sensitive then the permeability analyses as it is able to account for variables that permeability analysis is not able to do so, such as the size of the openings between spaces" (Guney, 2005; Guney, 2007; Guney and Wineman, 2008).

In a previous paper by Luiz Amorim (1997), research uncovered that modern houses in Recife are arranged according to a classification and grouping procedure that organizes domestic life into sectors that are interconnected by transitional spaces. The modern agenda's fundamental point

of view towards function is discussed as a problem. “A paradigm that the sectors were an idea, which architects thought with” (Hillier, 1996) was one focused idea. A sample of 140 modern houses in Recife, Brazil, built between 1950 and 1970 were the subject of this research. The houses were assessed according to the “sectors' organization” (Amorim, 1997), and this work inspired research in different sectors of Istanbul in the current study, as reported in this paper. As stated in Amorim’s (1997) study, “Social rules seem to have defined the precise set of suitable architectural schemes to attend the conceptions and preconceptions of house use. If that is true, modern architects’ houses were not only an expression of individuality, which is generally affirmed, but also carried in themselves genotypical information as significant as in vernacular manifestations”. In another paper, this researcher investigated changes in the organization of domestic space through time in Recife and mentioned that “House organization has changed through time, constantly adapting to respond to requirements imposed by social relations, codes of behaviour and family structure, as well as to express advances in building technology and to absorb new home appliances” (Amorim, 2001).

Research by Cunha (2005) also revealed the functional sectors and sector configuration in Brazilian domestic spaces. Apartment living was analyzed in the 1950s, 1970s and 1990s throughout the research. Certain striking findings are “the split between a `social' and a `service' entrance” and changes in service-related spaces. Service-related spaces tended to lose importance from the 1950s to 1970s, during which spaces for meal preparation, servants’ bedrooms and utility areas diminished in number. This paper presents parallel reflections that are closely related to the conclusion of the Istanbul study in this paper. A recent study by Cunha (2012) also investigates the spatial organization of middle-class apartments in Rio de Janeiro, Brazil, from the 1930s to the end of the 20th century by examining how different apartment plans express the numerous social changes that occurred during that period of time. The study was performed by examining the relationships between the service and social sectors. The transition component links these sectors, and the genotypes were investigated in that context.

4. Alteration and Specialization of Housing in the 20th Century In Turkey and particularly in Istanbul: The Milestones of Apartmentalization

Turkey was undergoing zoning shifts, arrangements and changes in the 1930s. In this study, investigation and analyses related to the first phase begins with 1930s and includes 1930-1954. A later investigation phase included 1954-1980, during which laws and regulations were developed for flat ownership in 1954 and differentiated by multiple-housing development, the emergence of small scale property developers, and, afterwards, municipality-arranged parcel allotment. Syntax changes and domestic space planning evolution are addressed later through analyzing two phases after researching space specialization (Eruzun, 1980), differentiation, order, and sector changes in housing plan structures.

Milestones from the Socio-Economic and Social Changes in Istanbul

In the 19th century, Beyoğlu’s city-center state reflected Istanbul’s cosmopolitan structure; its population increased due to the rising number of non-Muslims (caused by the large number of embassies), which enhanced housing development. Such development in the 1930s initiated the first phase addressed herein. Whereas the population increase in Istanbul during the 19th century was threefold, the Muslim segment continuously increased; however, accommodating the population ethnically also became more important (Tekeli, 1993). This situation was the precursor to zoning shifts in Istanbul and one of the most explicit indicators of spatial change and transformation.

Beginning in the mid-1950s, the social and economic dimensions changed. The second phase began in the mid-1950s, wherein socio-economic changes and milestones due to technological and zoning arrangements overlapped. The rapid urbanization period (1950-1960) and Menderes zoning were also defining moments in this process.

The Effect of Zoning Shifts in Istanbul: Emerging Milestones

The city was rapidly transformed into a western city profile between 1939 and 1950 by Mayor Kırdar, but expropriations increased housing problems (Unal, 1979). Istanbul's population rapidly increased after World War II, and the characterization of Prost's plans as leading to a stagnant city resulted in his being laid off in 1950. Afterwards, the rapid urbanization period (1950-1960) and Menderes Zoning Operations affected the city (Tekeli, 1993). Insufficient zoned land and housing supply were also important to this process (Edgu, 2003). Rapid urbanization also increased the urban land prices (Edgu, 2003); the "Possibility of the urban middle-class to pay the price of a parcel and construct a house gradually decreased" (Tekeli, 1997). Such conditions indicated a misperception in housing construction as well as arrangements in flat ownership and title. It is also important to address housing policy such that it overlaps with the house ownership (Tapan, 1996). Moreover, housing was approached as an investment, not necessarily a shelter. Such converging processes resulted in flat ownership (Edgu, 2003). The amended Article 26 of Land Register Law No 6217 in 1954 and the 1954 "Flat Ownership Law" generated the current conditions. This was the primary defining moment for the studies herein and began the second phase.

The Effects of Intra-Residential Technological Changes: Emerging Milestones

One of the most important intra-residential technological changes affecting housing space in the scope of this study is the television, which has been observed in living or social spaces, such as the lounge, dining room and living room. The television has altered behavioral patterns and modes. With changes in use, space syntax and semantics also began to change; for example, television was watched in crowded groups in living rooms and lounges that were previously only used for guests since black and white televisions first entered homes (Tokgoz, 1979) (Avci, 2008) (Bilgili, 2009).

TV development also yielded new consumption patterns for city residents. In the mid-1980s, color television entered Turkey (Aydın, 2003). Accepting a new communication instrument that appealed to the masses, such as the television, as a component of socialization defined a new approach for this period (Becker et al, 1975; Tokgoz, 1979). Television was also examined scientifically as a component of socialization after the 1970s (Chaffee et al, 1970).

Television entry into the domestic space affected design decisions and inter-spatial relationships for the entire house plan due to the frequent use of the space where the television was located. Located in lounges or living rooms, television stimulated more frequent use of these and related areas, which affected the relationships among other spaces in the house. The television was a technological innovation that affected spatial integration through space syntax.

Another important intra-residential technological change that affected multi-housing domestic space was central heating systems and the prevalence of central radiator installations in apartments. Doors inside the home were opened in houses with central heating. Spatial boundaries were lifted, and the organization defined by the stove-heated period was altered.

5. Traces of Apartmentalization in Istanbul through the 1930-1980 Period:

Revelation of Change and Analyses Performed

Method of Analysis

Space syntax, which provides significant data as method of analysis, is an important theory that is used to define the structural environment.

Used as a syntactic measurement method, the "Syntax 2D" software developed by University of Michigan was built using vision fields we named as "isovist" (Benedikt, 1979; Batty, 2001; Conroy Dalton, 2001; Edgu et al., 2012). The convex space concept was approached by scrutinizing the interspatial relationships within the space syntax theory; this approach reduces different-sized plans and spaces into cellular spaces whose relationships will be examined. The relationships among these cells are examined in convex spaces in which Syntax 2D handles the analyses through isovists. Within the definition of an isovist, walls, furniture and other systems that obstruct sightlines in space are all treated as walls and affect the determination of a visual field (Benedikt, 1979; Turner and Penn, 1999; Batty, 2001; Turner et al., 2001; Conroy Dalton, 2001; Unlu et al., 2009; Edgu et al., 2012)

The requirements for specifying an analysis method in "Syntax 2D" are crucial for examining the relationships among different samples in the 1930-1980 period. The "smallest grid cell" was defined to enable comparison of different plan samples in the software, which operates by constructing grid fragmentation. Plans digitally drawn in AutoCAD format (.dwg) were transferred to the "Syntax 2D" program in a manner proportional to the real plan sizes; consequently, the "smallest grid cell" that the program calculated for the field locations in the main impact field was analyzed and standardized for every distinct sample.

Because the main analysis field in each entire plan is cleared of all elements that obstruct the inner plan vision, it can also be referred to as the used net field; according to this logic, the active grid-cell count of a plan with a 150-m^2 net field was approximately 3450, that of a 120-m^2 plan was 2760, and that for a 100-m^2 plan was approximately 2300. This approach enabled comparison of inter-plan integrations and depth values. The visible and perceived field analyses were performed on plans within this context. As a result of the analyses, the tendencies of the alterations between two different phases emerged together with generation of the mean values of the phases. The relationships of these tendencies with parameters such as changes in construction systems, design inclinations, zoning rules, technological changes and changes in socio-economic structures will also be discussed. Finally, the statistical relationships of the different phases will also be scrutinized, and the addressed comparisons will be examined using the "Statistical Package for the Social Sciences" (SPSS) program.

Discussion on Relationships Using the Concepts Underlying the Analysis Method, Assumptions and Research Method

An important decision related to the analysis method is to identify three distinct intra-plan areas (sectors) in different configurations of each plan and to analyze the syntax values for each area. Using the plan types and convex spaces inside such sectors, intra-plan space cells were identified and analyzed. These three sectors were differentiated as the "bedroom area", "living area" and "service area". The bedroom area included the bedrooms, bathrooms and interconnecting area spaces and related balconies; the living area included the lounge, dining room, living room, apartment entry spaces, hall, related balconies, interconnecting area spaces and related extensions; the service area included the halls, hallways outside the first two areas, the kitchen, maid's rooms, cellar, office areas related to the kitchen, related balconies, restrooms and shower

areas, and related intermediary spaces. This analysis structure is important for the analysis method and model.

Domestic space plan samples were selected from the Turkish Architecture Journal "Arkitekt", which was published from the end of the 1920s through the beginning of the 1980s. The samples were selected considering that apartment plan samples are designed based on one floor plan, which can demonstrate the development direction for a city and similar income-level households. The samples were from such neighborhoods as Nişantaşı, Cihangir, Ayaspaşa, Taksim, Maçka, and Harbiye through 1950. After 1950, Moda, Bomonti, Şişli, Bebek, Elmadağ, Etiler, Çiftehavuzlar and Suadiye were also included.

The applied syntactic data were Isovist area, Isovist perimeter, Circularity and Compactness, Connectivity, Depth and Integration.

These data values were calculated separately for every plan, including values of sectors differentiated as "Bedroom Area", "Living Area" and "Service Area". Bathroom and kitchen values were also calculated in every plan. The mean syntactic values were obtained for the six concepts listed above by dividing the total data value of each plan by its own grid count (Table 1 and Table 2). Contingently, calculations were carried out via arithmetic averaging of the grid values of areas or of a single space. The names applied for each data group for which a mean value was obtained are listed below:

- Mean isovist area
- Mean isovist perimeter
- Mean circularity and mean compactness
- Mean connectivity
- Mean depth
- Mean integration

Basic Results Obtained from the Analyses

In phase 1, analyses were performed on 24 plans from 20 apartment samples, and 13 plans from 11 apartment samples were analyzed in phase 2. Table 1 and Table 2 show the data for phase 1 and phase 2, respectively. The figures display the logic of the plan analyses on a sample plan (Figures 1 - 3). The syntactic tendencies provided by the analysis will be discussed later on. The results of the x^2 (chi-square) tests generated with the SPSS program that statistically define certain relationships between two phases will be addressed as well.

The operation used to obtain the arithmetic mean and calculate values based on syntactic concepts was performed by considering the syntactic grid values of relevant singular spaces or differentiated areas. Sample plans that demonstrate the addressed grid fragmentation and area structure are provided below (Figures 1 – 3).

The intra-residential "net used area" value had an average phase value between 140 and 150 m^2 when the averages of the phases were obtained separately. The average "net used area" of the samples in 1930-1954 was 140,46 m^2 and that of samples from 1954-1980 was 149 m^2.

Similar average net residential m^2 values for each phase were encountered; averaging samples retrieved from two phases was an important assumption that made the analyses possible and meaningful. Similar average values of plan sizes from different phases facilitated the comparison between these two phases despite the existence of various sizes of plan types. Similar values for

plan sizes on average also enabled direct comparison of approximate sizes proportional to the "23 grids per m^2 value" structure of the analyses. Thus, it was possible to build interpretations by making comparisons among many calculated values, especially the mean integration values and mean depth values.

Table 1: Selected Apartment Housing Plans for the Analysis and the Results of Syntactic Analysis – Period 1 (1930-1954)

Construction Year	Name & Neighborhood	Net Used m2 / plan	Mean Isovist Area (+E6) cm2	Mean Isovist Perimeter (+E6) cm2	Mean Compactness (+E6)	Mean Circularity (+E6)	Mean Connectivity	Mean Depth (+E6)	Mean Integration (+E9)
1959	Birkan Apartments– Bebek	225	509322	4851	95,30	55,96	1198	2,46	2813
1960	Kervansaray Apartment– Elmadağ	156	365119	3650	93,56	41,67	850	2,42	1306
1962	An Apartment– Nişantaşı 1	132	282001	3533	75,51	49,44	655	2,22	1011
1962	An Apartment– Nişantaşı 2	164	351758	3911	85,48	50,74	824	2,18	1650
1966	Günaydın Apartment– Nişantaşı	177	315625	3952	77,28	53,86	707	2,50	1142
1973	Türksan Housing Complex– Etiler 1	96	229132	2870	77,93	42,18	535	2,23	557
1973	Türksan Housing Complex– Etiler 2	56	126285	2151	56,20	41,27	300	2,40	169
1976	Tekül Apartment– Çiftehavuzlar	113	240783	3320	75,07	50,62	563	2,20	750
1976	Tahincioğlu Apartments– Çiftehavuzlar	272	403795	4770	83,40	62,45	939	2,40	2494
1978	Yapı Kredi Bank Welfare and Pension Foundation Valikonağı Housing Complex – Teşvikiye	172	387668	4018	87,74	50,93	896	2,33	1775
1979	Sazak Building– Çiftehavuzlar	142	199839	2753	66,91	44,98	459	3,07	436
1979	Spot Building with a Circular Plan – Suadiye	108	209977	2758	74,26	41,38	493	2,33	534
1973	Tura Apartment– Etiler	124	300500	3457	83,00	44,54	707	2,15	1213
Period 2 Average		149	301684	3538	79,36	48,46	702	2,38	1219,23

Construction Year	Name & Neighborhood	Bathroom / Mean Depth (+E6)	Bathroom / Mean Integration (+E9)	Kitchen / Mean Depth (+E6)	Kitchen / Mean Integration (+E9)	Bedroom Area / Mean Depth (+E6)	Bedroom Area / Mean Integration (+E9)	Living Area / Mean Depth (+E6)	Living Area / Mean Integration (+E9)	Service / Mean Depth (+E6)	Service / Mean Integration (+E9)
1959	Birkan Apartments– Bebek	3,75	312	2,65	795	2,85	924	2,09	4902	2,73	721
1960	Kervansaray Apartment– Elmadağ	2,77	233	2,51	356	2,58	542	2,12	2224	2,67	322
1962	An Apartment– Nişantaşı 1	2,31	522	2,36	454	2,29	611	2,01	1592	2,58	275
1962	An Apartment– Nişantaşı 2	2,71	277	2,42	653	2,36	724	1,89	2965	2,44	638
1966	Günaydın Apartment– Nişantaşı	3,29	317	2,59	436	2,61	768	2,31	1623	3,03	265
1973	Türksan Housing Complex– Etiler 1	2,56	140	2,39	230	2,35	303	2,07	876	2,39	230
1973	Türksan Housing Complex– Etiler 2	2,43	69	2,47	96	2,50	82	2,19	271	2,45	89
1976	Tekül Apartment– Çiftehavuzlar	2,59	183	2,47	290	2,34	469	2,03	1106	2,44	317
1976	Tahincioğlu Apartments– Çiftehavuzlar	2,52	1107	2,50	1328	2,38	1764	2,21	3579	2,74	976
1978	Yapı Kredi Bank Welfare and Pension Foundation Valikonağı Housing Complex – Teşvikiye	3,03	244	2,31	969	2,65	602	1,99	3188	2,37	882
1979	Sazak Building– Çiftehavuzlar	3,63	118	3,82	136	3,20	222	2,71	813	3,82	136
1979	Spot Building with a Circular Plan – Suadiye	2,59	150	2,40	362	2,49	283	2,13	870	2,40	362
1973	Tura Apartment– Etiler	2,55	207	2,34	439	2,37	569	1,87	2117	2,37	393
Period 2 Average		2,83	298,38	2,56	504,15	2,55	604,85	2,12	2009,69	2,66	431,23

Table 2: Selected Apartment Housing Plans for the Analysis and the Results of Syntactic Analysis – Period 2 (1954-1980)

Construction Year	Name & Neighborhood	Net Used m2 / plan	Mean Isovist Area (+E6) cm2	Mean Isovist Perimeter (+E6) cm2	Mean Compactness (+E6)	Mean Circularity (+E6)	Mean Connectivity	Mean Depth (+E6)	Mean Integration (+E9)
1931	Park Apartment – Nişantaşı	164	285652	4124	58,85	63,01	662	2,33	1135
1932	Nan Apartment – Nişantaşı	95	241977	3476	67,81	53,25	562	2,10	659
1932	Hüsnü B. Apartment – Nişantaşı	132	272976	4019	66,64	63,48	636	2,22	946
1932	Mühendis Derviş Bey Apartment – Cihangir	121	245047	3509	67,70	55,18	569	2,34	760
1932	Bosfor Apartment – Ayaspaşa	135	280441	3549	78,75	49,41	656	2,31	922
1932	İstiklal Apartment – Taksim	149	348980	4375	77,11	59,54	814	2,17	1434
1932	Melek Apartment – Nişantaşı	120	219102	3665	59,03	67,37	512	2,23	735
1933	Pertev Apartment – Taksim	151	283867	3587	76,85	51,44	656	2,52	854
1933	Ceylan Apartment – Taksim	216	423339	6029	67,49	92,44	990	2,19	2518
1933	Agop Efendi Apartment – Taksim	66	189903	3364	55,52	64,52	439	1,99	408
1934	İskece Apartment – Maçka	95	211039	3285	65,21	55,30	496	2,15	548
1934	Şeref Apartment – Nişantaşı	169	316005	4741	65,23	76,99	858	2,20	1998
1939	An Apartment – Taksim	108	228952	3577	64,99	61,09	533	2,35	557
1940	Doğu Apartment – Taksim	163	273152	3768	75,06	55,72	634	2,52	893
1946	An Apartment in Maçka 1	175	400738	3990	91,15	47,65	933	2,34	1802
1946	An Apartment in Maçka 2	97	225265	3019	71,79	42,88	520	2,39	525
1946	An Apartment in Maçka 3	120	298265	4017	70,76	58,77	692	2,01	1207
1949	Başaran Apartment – Harbiye	186	270806	3833	68,33	59,32	629	2,65	951
1950	Birgiler Apartment – Moda	100	203344	3175	62,82	55,89	474	2,27	507
1951	İlbay Apartment – Bomonti	84	190004	3153	60,27	55,77	448	2,20	439
1951	Sadıklar Apartment – Şişli 1	160	265720	3274	81,77	46,78	624	2,64	817
1951	Sadıklar Apartment – Şişli 2	179	261289	2402	77,99	48,89	608	2,57	939
1951	Sadıklar Apartment – Şişli 3	187	345627	4066	80,57	53,81	801	2,34	1582
1951	An Apartment – Nişantaşı	198	332044	4466	72,47	67,20	767	2,42	1497
Period 1 Average		**140,46**	**275647,29**	**3769,33**	**70,59**	**58,57**	**646,38**	**2,31**	**1026,83**

Construction Year	Name & Neighborhood	Bathroom / Mean Depth (+E6)	Bathroom / Mean Integration (+E9)	Kitchen / Mean Depth (+E6)	Kitchen / Mean Integration (+E9)	Bedroom Area / Mean Depth (+E6)	Bedroom Area / Mean Integration (+E9)	Living Area / Mean Depth (+E6)	Living Area / Mean Integration (+E9)	Service / Mean Depth (+E6)	Service / Mean Integration (+E9)
1931	Park Apartment – Nişantaşı	2,27	779	3,05	297	2,35	996	2,20	1583	2,47	825
1932	Nan Apartment – Nişantaşı	2,41	138	2,17	294	2,40	273	1,93	922	2,22	249
1932	Hüsnü B. Apartment – Nişantaşı	2,43	445	2,65	257	2,25	715	2,10	1329	2,50	360
1932	Mühendis Derviş Bey Apartment – Cihangir	2,65	193	2,26	369	2,50	353	2,08	1043	2,36	334
1932	Bosfor Apartment – Ayaspaşa	2,55	209	2,54	248	2,40	665	2,18	1305	2,62	216
1932	İstiklal Apartment – Taksim	2,69	239	2,53	234	2,35	723	2,02	2060	2,39	508
1932	Melek Apartment – Nişantaşı	2,48	173	2,65	172	2,32	478	2,01	1194	2,60	208
1933	Pertev Apartment – Taksim	2,85	228	2,82	289	2,68	493	2,31	1338	2,77	285
1933	Ceylan Apartment – Taksim	2,70	584	2,80	443	2,37	1228	1,96	3920	2,58	681
1933	Agop Efendi Apartment – Taksim	2,42	91	2,38	74	2,09	287	1,87	536	2,40	68
1934	İskece Apartment – Maçka	2,49	112	2,45	140	2,21	438	2,05	751	2,44	143
1934	Şeref Apartment – Nişantaşı	2,57	469	2,33	840	2,22	1620	2,07	3019	2,48	605
1939	An Apartment – Taksim	2,42	271	2,48	259	2,45	414	2,23	767	2,45	268
1940	Doğu Apartment – Taksim	2,50	355	2,55	412	2,58	749	2,41	1217	2,58	555
1946	An Apartment in Maçka 1	2,69	403	2,67	583	2,65	578	2,06	2971	2,55	708
1946	An Apartment in Maçka 2	2,59	197	3,19	99	2,44	363	2,07	808	3,37	85
1946	An Apartment in Maçka 3	2,56	174	2,30	500	2,19	641	1,78	1814	2,42	424
1949	Başaran Apartment – Harbiye	3,69	144	2,81	264	2,83	546	2,44	1657	2,68	506
1950	Birgiler Apartment – Moda	2,29	224	2,65	133	2,35	310	2,13	649	2,72	150
1951	İlbay Apartment – Bomonti	2,39	144	2,45	154	2,27	333	2,08	625	2,33	263
1951	Sadıklar Apartment – Şişli 1	3,04	271	3,10	278	2,71	541	2,37	1474	3,07	271
1951	Sadıklar Apartment – Şişli 2	2,71	434	3,56	253	2,47	999	2,40	1185	3,07	279
1951	Sadıklar Apartment – Şişli 3	2,97	278	2,64	403	2,61	651	2,16	2178	2,69	384
1951	An Apartment – Nişantaşı	2,86	517	3,08	334	2,56	818	2,22	2382	2,57	885
Period 1 Average		**2,63**	**294,67**	**2,68**	**305,38**	**2,43**	**633,83**	**2,13**	**1530,71**	**2,60**	**386,40**

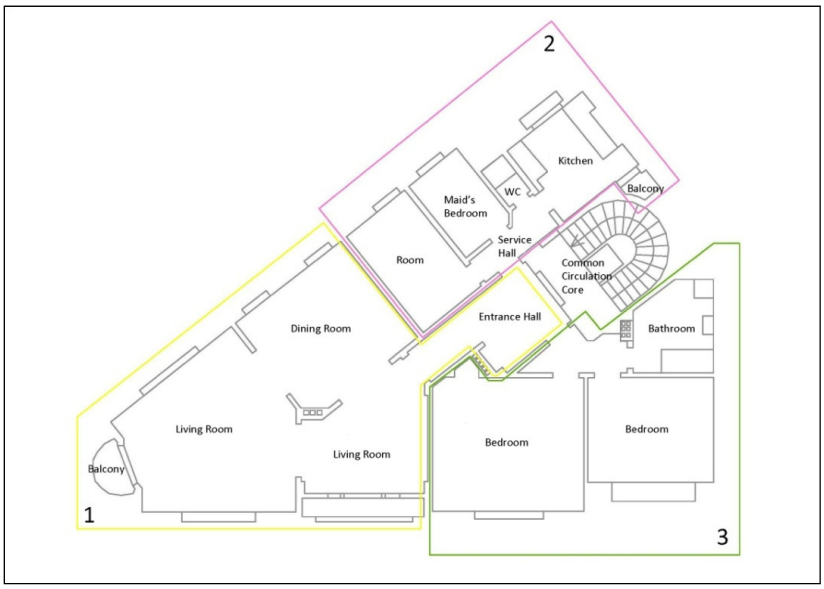

Figure 1: Example Analysis Plan, 1933 Pertev Apartment of Taksim (Phase 1), showing division of three main areas where syntactic analyses are conducted (with color differences): 1-Service Area, 2-Living Area, 3-Bedroom Area

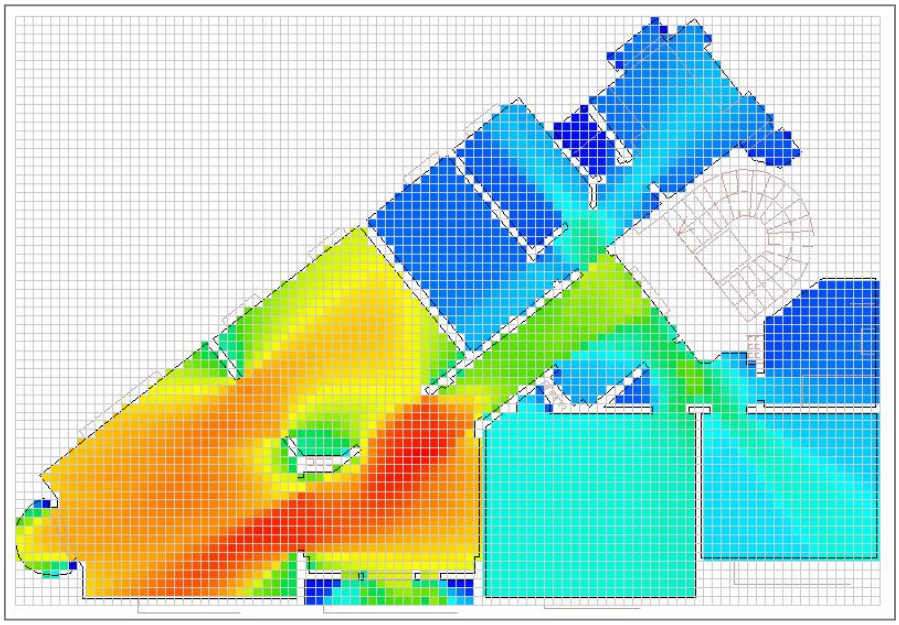

Figure 2: 1933 Example Analysis Plan, Pertev Apartment, Taksim, showing allocation of 23 grids per m^2 for syntactic analysis superposed with visual representation of integration analysis

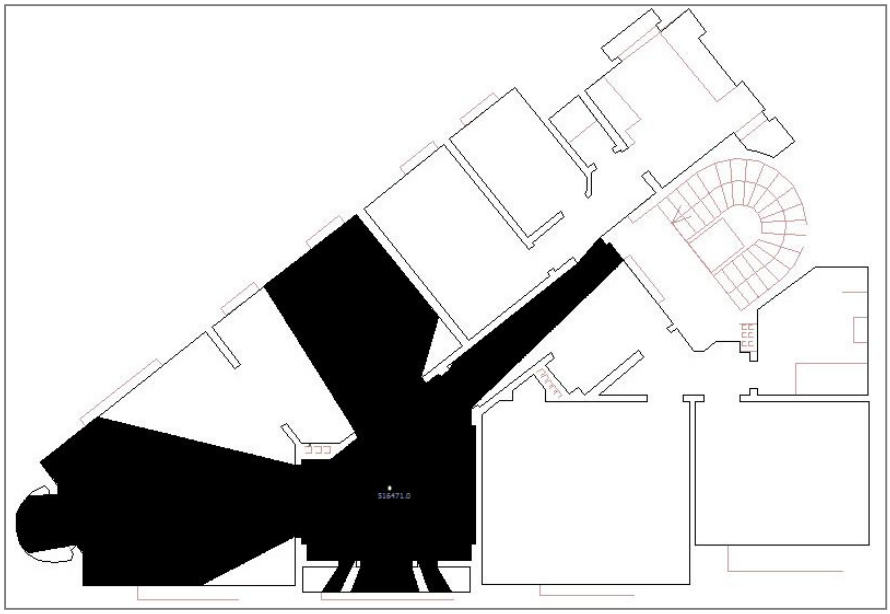

Figure 3: 1933 Example Analysis Plan, Pertev Apartment, Taksim, showing an example isovist point and its visual field area

In the analyses, a comparison was carried out between the average values of the first and the second phase. Using the means of values based on the space syntax concepts, we attempted to understand the variation tendency between these two distinct phases. Diagrams that address the variation tendencies of the mean values between two phases are provided below (Figures 4 – 9). These diagrams and the charts provided previously (Table 1 and Table 2) will be considered together for a better understanding of the results of this study.

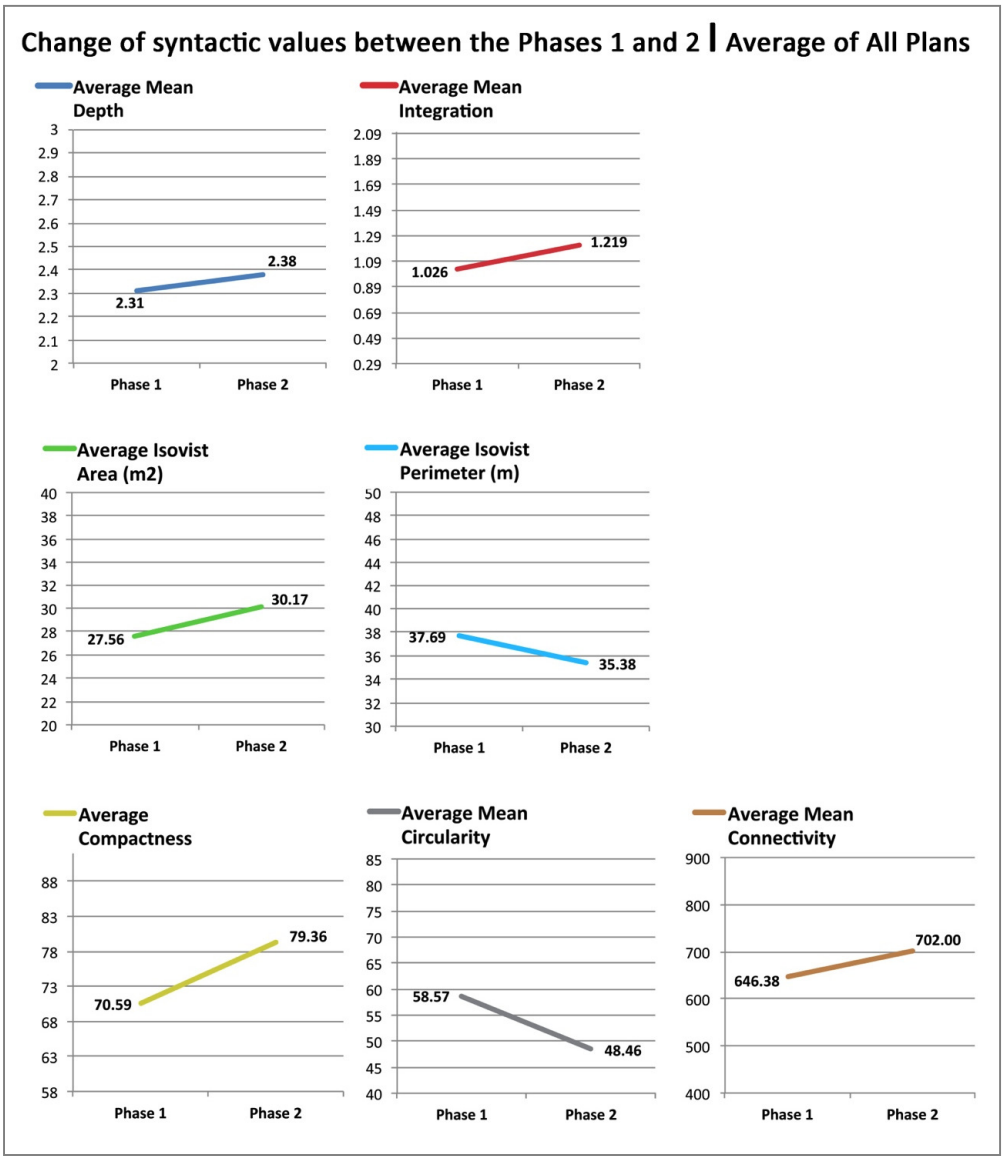

Figure 4: Change of Syntactic Values Between Phases 1 and 2: Average of All Plans for Values of Average Mean Depth, Average Mean Integration, Average Isovist Area (m^2), Average Isovist Perimeter (m), Average Compactness, Average Mean Circularity and Average Mean Connectivity.

The tendencies in these charts involve results that constitute the main axis of the study. In Figure 4, the average mean integration value (considering the average of all spaces in a plan and the average of all plans), which rises from 1026 to 1219 in the transition from the first phase to second, emerged as an extremely important finding. When the reason for this rise was investigated, we observed that the effect of the mean integration value for living areas rose to the 2010 level in the second phase, whereas it remained at the 1531 level in the first phase, and thus had a significant effect. The transformation of the living area (consisting of the lounge, living room, and entry halls of the housing space) into exquisitely more integrated spaces can be interpreted as a reflection of the effect of television (which began broadcasting in Turkey in 1952 and became widespread by the 1970s), especially in terms of the changing state of lounge and living room areas, which began to be used extensively in the spatial setup. Of course, television is not the only reason for this change. Heating systems were as effective in driving change as television because inter-spatial boundaries were removed and doors were opened, also supporting this transformation. In addition, as a result of increasing population and socio-economic changes, the

living area reached a more integrated position. The depth value of the living area remained nearly unchanged in the second phase, whereas its integration position was strengthened due to little change to its allocation in the plan.

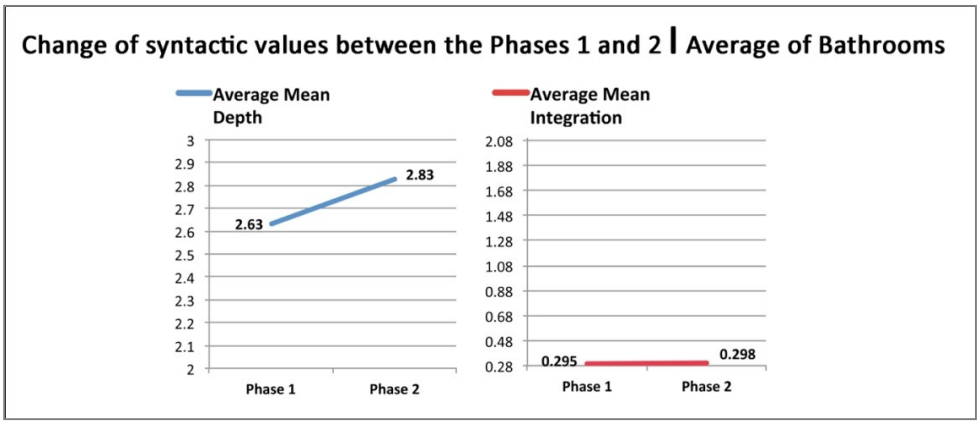

Figure 5: Change of Syntactic Values Between Phases 1 and 2: Average of Bathrooms Only for Values of Average Mean Depth and Average Mean Integration.

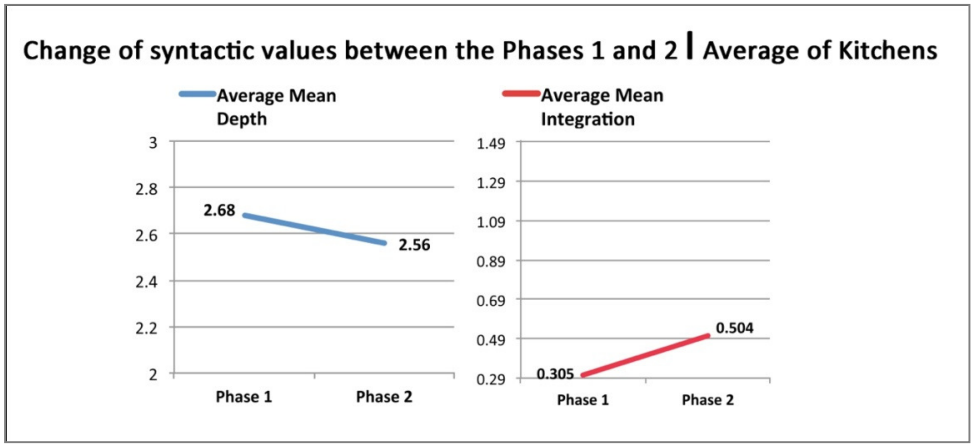

Figure 6: Change of Syntactic Values Between Phases 1 and 2: Average of Kitchens Only for Values of Average Mean Depth and Average Mean Integration.

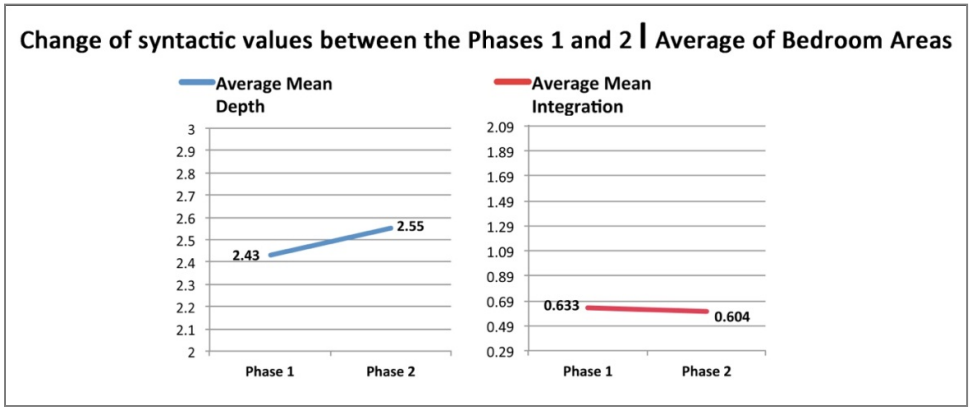

Figure 7: Change of Syntactic Values Between Phases 1 and 2: Average of Bedroom Areas for Values of Average Mean Depth and Average Mean Integration.

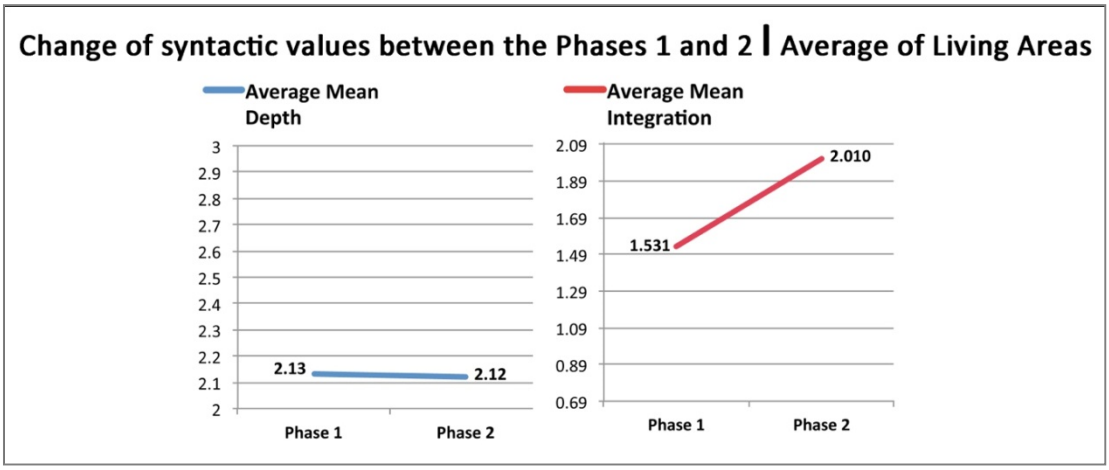

Figure 8: Change of Syntactic Values Between Phases 1 and 2: Average of Living Areas for Values of Average Mean Depth and Average Mean Integration.

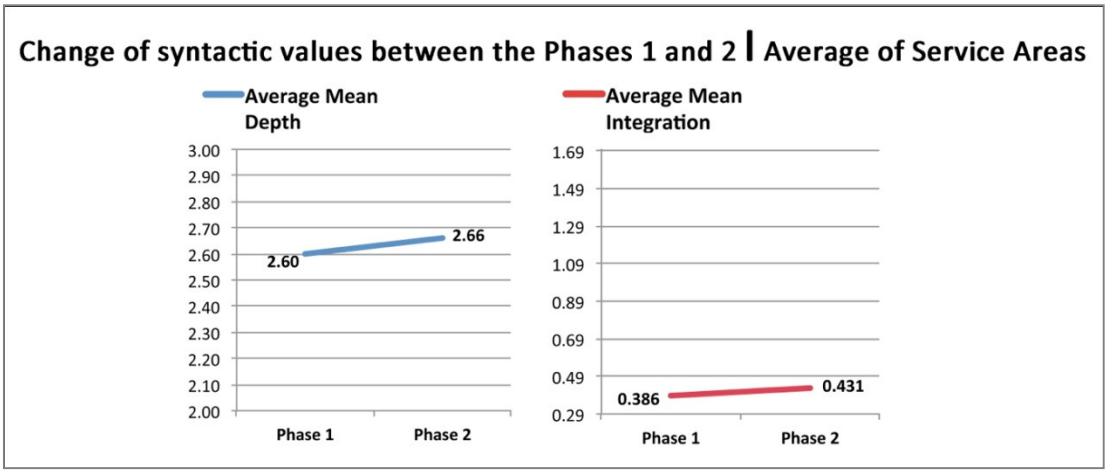

Figure 9: Change of Syntactic Values Between Phases 1 and 2: Average of Service Areas for Values of Average Mean Depth and Average Mean Integration.

Among the phases illustrated in Figure 4, the mean depths of the plans revealed a tendency to increase from the first phase to the second; although this change was not strong, it provided traces of a set of gradually deepening areas. If we consider that the mean integration (Figure 4) increased at a rather sharp rate by moving from the 1026 level to the 1219 level, the increase in the depth of the mean of the entire plan in the second phase was proof of a strong deepening in certain areas. The increase in the mean depth of the service area (Figure 9) and bedroom area (Figure 7) drove the deepening tendency in the plan as a whole. Despite the deepening in these areas, the singular tendency toward shallower or more integrated (Figure 6) space in the kitchen areas in the second phase draws attention. In this sense, the tendency exists because the mean depth value decreased from the 2,68 level to the 2,56 level. In the second phase, a significant increase in the integration of the kitchen space (Figure 6) is an important result captured by the movement from the 305 level of the first phase to the 504 level in the second phase. In this case, we underscore once more that the kitchen space also experienced a significant change in integration in addition to the living area spaces during the second phase. In the second phase, the transformation of kitchen space into a shallower space (as shown by the decrease in the mean depth value) and its attainment of a more integrated position within the entire plan (as shown by the increase in the integration value) are both important findings. This situation stemmed from variation of the spaces included in the service area, which moved away from a closed internal

setup and thus shifted to a deeper space state in the second phase.

Although service spaces covered more fields in the first phase than in the second phase in terms of m^2 (i.e., maid's rooms, internal hallways, office rooms and restrooms), this area shrunk in the second phase in terms of total fields; although the kitchen space became a shallower space, separations occurred in the plan as restrooms, service rooms and singular deep spaces emerged.

When we look at bathroom space, although the integration values in the plan were similar for both phases (Figure 5), its gradually deepened position (Figure 5) stemmed from the deepened position of bedrooms (Figure 7) in the second phase.

Relationships with The Obtained Correlations and Tendencies

In addition to the analyses, the results of x^2 (chi-square) tests (generated with the SPSS program) that statistically express certain relationships between two phases will be addressed. As shown in Table 1 and Table 2, the tendencies between the first and second phase were also statistically tested.

As a result of the test between the phases and mean isovist area, the x^2 (chi-square) was 1.722, the degree of freedom (df) was 1, and the probability value (p) was 0.189. Although the result was statistically above the $p<0.05$ level, it was important to verify the tendency of the increase in the isovist area in the second phase at the 81% level. Because this tendency was in direct proportion to the values of such concepts as mean integration value and mean connectivity, this process statistically verified the tendency of an increase in terms of the integration values throughout the plan during the transition from the first phase to the second. This situation, which can also be observed in Figure 4, had a directly proportional relationship with the increased integration of living areas, the deepening of the bedrooms and the additional integration of the kitchen space in the second phase.

As a result of the test between phases and mean compactness, the x^2 (chi-square) was 5.515, the degree of freedom (df) was 1, and the probability value (p) was 0.019. This result is statistically below the $p<0.05$ level, and this relationship, whose probability value was also below 0.005, was statistically strong at the 98% level. The compactness value calculated during the analyses is also important in terms of its inversely proportional relationship with the circularity value. An increase in the value is an indicator of gradual differentiation throughout the plan of the general averages of the mean dimensions. Briefly, this value is accepted as an indicator of dimensional tightening of the convex spaces. Considering the differences in the first and second phases, Figure 4 also shows that the mean compactness value had an increasing tendency that contrasted with the mean circularity value. The statistical evaluation carried out over the 37 samples also confirmed this observation. It could be inferred from this situation that the differences among the lengths of the plan morphologies in the second dimension (i.e., width and length) began to increase and that the plan center began to shift towards the perimeters. Alternatively, the convex spaces with different integration values throughout the plan began to overlap in a single narrow field with a high integration value and were forced to use this field as a connection field due to tightening of the interconnecting areas among the convex spaces. This result should be interpreted and discussed particularly around the circularity value in the second-phase analysis samples.

As a result of the test between phases and mean circularity, the x^2 (chi-square) was 5.515, the degree of freedom (df) was 1, and the probability value (p) was 0.019. As shown in Figure 4, the tendency between the phases and mean circularity and the trend of moving away from the center and the differentiation in the plan were detected in the second phase together with a decreasing

mean circularity. Although it was statistically below the p<0.05 level, the probability value of 0.019 revealed that this relationship was also strong at the 98% level because it remained below the 0.05 level. Because this situation identified the inversely proportional relationship between circularity and compactness, it also proved the accuracy of interpreting these variables together. In the first phase, a morphological structure similar to a circle was observed due to the increase in the mean circularity value. In the second phase, the restricted high circularity value of the isovist points (especially in the dispersing fields) as well as the high convex space averages in terms of compactness resulted in decreasing mean circularity.

As a result of the test between phases and mean depth, the x^2 (chi-square) was 3.430, the degree of freedom (df) was 1, and the probability value (p) was 0.064. In terms of probability, by remaining above the 0.05 but not reaching the p<0.05 level, the 0.064 value still generated a probability near 83%. Despite the decrease of the mean depth, the shallower tendency was demonstrated overwhelmingly in the kitchen space and slightly in the living area in the second phase, but the situation that most affected this test was the deepening bathroom space and bedroom area space. As a result of this test, the general plan structure was gradually deepened in the second phase (Figure 4), which was also observed as a statistical tendency. The reason for the probability of this tendency to remain higher than 0.05 but not stronger was the shallower tendency of such spaces as the kitchen and lounge.

As a result of the test between phases and mean depth of bathroom space, the x^2 (chi-square) was 3.124, the degree of freedom (df) was 1, and the probability value (p) was 0.077. As shown in Figure 5, the deepening tendency of the bathroom space was statistically calculated as p=0.077, and thus, the deepening tendency was also statistically obtained with a probability of approximately 82%.

As a result of the test between phases and mean integration of kitchen space, the x^2 (chi-square) was 3.124, the degree of freedom (df) was 1, and the probability value (p) was 0.077. The gradual shift of the kitchen to a higher mean integration value position in the second phase was observed in this analysis. This relationship that was seen in Figure 6 overlapped with the statistical result with a probability at p=0.07, thus exhibiting a similarity.

6. Conclusion

This study scrutinized the differences and similarities among the three areas of a plan identified as “Bedroom Area”, “Living Area” and “Service Area”. The bathroom and kitchen areas were also individually examined within the structure of the analyses and from the plans of the samples. In the two phases, analyses were performed relative to such space syntax concepts as isovist area, isovist perimeter, circularity and compactness, connectivity, depth and integration.

As a result of the correlations between the syntactic values and phases tested with the SPSS program, the test performed between the phases and mean isovist area statistically supported the tendency towards increasing mean integration values throughout the plan during the transition from the first phase to the second phase. The test performed between the phases and mean depth values of the bathroom space emphasized the deepening tendency of the bathroom space in the second phase; the test performed between the phases and mean depth values of the kitchen space revealed the gradual shift of the kitchen to a higher mean integration value position in the second phase.

When the relationships between the two phases were scrutinized within the context of spatial changes, a change was observed in the convex spaces of the second phase with respect to the

plans whose dimensional data were gradually differentiated from each other; this situation can be interpreted as traces of the change in terms of movement of the fields consisting of many different spaces in the first phase towards one space in the second phase. The circularity value gradually decreased in the second phase. In the first phase, the structure of the plans (including the entry fields or hallways) was observed, and the results supporting the tendency that the center should be located close to the hall (which was the most important dispersion field of the bedroom area) were obtained from the first phase samples. The change in the living area spaces from three or more convex spaces in the first phase was an important result; this situation pointed the movement towards a singular living area in the second phase because the integration valued spiked severely. As a result of conditions stemming from the changes in zoning rules and differentiation of width and length in the parcels, a tendency was observed to move away from convex spaces whose dimensional data were close to those of more convex space geometries, whose dimensional values were different.

It was also observed that the general tendency toward a decrease in the mean circularity value in the second phase was due to the divergence of areas connected with narrow interconnecting zones in the plan organization. The structure that was observed in second phase plan types, in which there were fractures in the form of convex space in the plan continuity, had the effect of decreasing the mean circularity. The mean circularity has a tendency to decrease in a structure in which the interconnecting areas among the areas are tightened, narrowed and concentrated on a single field with a high mean integration.

Finally, the bathroom area demonstrated a similar tendency in the first and second phases in terms of integration value, and its deepening structure in terms of mean depth facilitated an increased vicinity to the bedroom area, thus demonstrating a deeper structure in the second phase within the context of privacy.

Revealing the existence of relationships between space and social powers, the space syntax theory made it possible to discuss social changes via numeric analyses. Space syntax enabled us to analyze different morphologies from the same quantitative foundation and to scrutinize the differences, similarities and changes in the samples between the two phases and among one another. Syntactic analyses based on the isovist were used for detection in this situation.

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