THE EFFECTS OF PROPOSED BRIDGES ON URBAN MACROFORM OF ISTANBUL:
a syntactic evaluation

003

Ayşe Sema Kubat
Faculty of Architecture, ITU
H. Serdar Kaya
Faculty of Architecture, ITU
Fırat Sarı
Faculty of Architecture, ITU
Gülşen Güler
Faculty of Architecture, ITU
Özlem Özer
Plan-Art Ltd.

Keywords:

Urban macroform
Sustainability
Continuity lines
Urban morphology
Space syntax
Transportation network
Istanbul

Ayşe Sema Kubat
Faculty of Architecture, Istanbul Technical University, Taskisla, 34437, Taksim, Istanbul, Turkey
+90 212 2931300
kubat@itu.edu.tr
H.Serdar Kaya
Faculty of Architecture, ITU
hserdarkaya@yahoo.com
Fırat Sarı
Faculty of Architecture, ITU
firatsari@hotmail.com
Gülşen Güler
Faculty of Architecture, ITU
gulergu@itu.edu.tr
Özlem Özer
Plan-Art Ltd.,
+90 216 4436476
oslem.oser@gmail.com

Abstract

In recent years, the third bridge on Istanbul Bosporus has become a topic of lively debate but the probable results of introducing this new connection for the two sides of Istanbul are yet to be examined and evaluated. This paper investigates impacts of the existing and proposed bridges on the spatial development of the metropolitan area of Istanbul and explains the interaction between land use on urban macro form and transportation network via simulating the probable effects of the third bridge on the urban structure. The study has prepared and examined two syntactic maps that refer to two different time periods; the current situation and the future city network according to the proposed alternatives. The land use and urban growth data have also been collected for the two time periods available; before the two bridges were built and the current situation.

The study aims to estimate the possible effects of the new alternatives on land use, urban spread and location of Central Business District (CBD), by comparing the data of the earlier, current and future situations. According to syntactic analyses, it is clearly seen that the activities of CBD have expanded from the historical Eminönü district to the new CBD of 1980's through Mecidiyeköy and Maslak axis, which also reflects the existing situation of CBD of Istanbul (Figure 5) (Kubat, 2001). The syntactic maps further show a shift of the central cores of Istanbul and a strong interaction between urban macro form and the existing and proposed bridges. This shift has been a potential threat for the northern sides of the metropolitan city, a vital region for the city as it has river basins and forest areas.

Space syntax have been built on the concept of pedestrian movement. This research, however, also investigates transportation system and traffic flow, which differs from pedestrian movement. The traditional ways to represent the urban network have some inefficiencies in making depictions about vehicular movement. Therefore, in order to represent the urban grid with priority given to the vehicular movement, a new deformed map of Istanbul has been prepared. Both the syntactic analyses and the analyses of deformed transportation network show the dominant character of highways and their effects on land use, and thus the possible direction of urban sprawl in Istanbul.

In light of the two bridge experiences, and comparative analysis of urban macro form in various years from 1925 to 2005 using space syntax, this study will help to evaluate the likely effects of the proposed bridge alternatives on the urban development for sustainable future of Istanbul Metropolitan area. The study aims to be a source for

urban planning in greater Istanbul and offer recommedations for today and future. The results of this study can also benefit other cities that deal with similiar problem of connecting two urban regions.

Introduction

Istanbul, as the only city in the world that sits astride two continents, has been one of the most attractive cities to settle throughout the history. It has grown on four cores which were being settled independently in the 7th century BC: Byzantium (Sarayburnu) and Sykae (Galata) in European side and Khalkedon (Kadıköy) and Chrispolis (Üsküdar) in Asian side. After the 1960's the city has outgrown these cores due to rapid population increase. To enable daily transportation between the two sides of Istanbul, two bridges have been built in 1973 and 1988. The construction of these bridges have affected maritime and rail transportation as well as the public transportation negatively. Even after the construction of the first bridge on Bosporus, the growth feature of the city changed from "sea dependent" to "highway dependent" growth and CBD has shifted towards the northern regions of the city. Today, even these two bridges cannot meet the transportation needs of the metropolitan Istanbul. A third bridge over the Bosporus and a tunnel project between the two sides are the two alternatives proposed by government to solve the traffic problem that threatens the natural, physical, social and economical life of the city.

Space syntax is a quantitative and thus an objective method as it integrates spatial data with other types of information such as land uses or statistical data. It has an ability to test the alternative design proposals and also to forecast the activities for future. This paper utilizies space syntax methodology to examine the distribution of integration in certain areas with and without the bridges (existing bridges and proposed) in order to see whether bridges 'plug onto and intensify' local integration patterns or completely modify such patterns. The probable effects of the proposed bridge on spatial organization of Istanbul is also analysed. As the accessibility and integration are the crucial features for the development process of the city, the main arterial roads and connections between the two sides of Istanbul have great importance. The past two bridge experiences are utilized to evaluate the affets of main arterial roads and connections between the two sides of the city.

Methodology

Syntactic maps show that transportation system is closely related with the urban system. Still, there are two kinds of movement that should be taken into consideration as they have different characteristics: Pedestrian and vehicle movement. For Istanbul, transportation system shaped according to vehicle movement, natural environment and especially the hilly topography gives the main form to the city. Hillier (1996) has stated that "pedestrian densities on lines in local areas can usually be best predicted by calculating integration for the system of up to tree lines away from each line (radius 3 integration) while cars on larger scale roads (though not in local areas, where radius 3 is the best predictor) depend on higher radius integration because car journeys are on the whole longer and motorists therefore read the matrix of possible routes according to a larger scale logic than pedestrians."

In addition to pedestrian and vehicle movements, two different axial maps were used in order to evaluate these different types of movements This could be seen as a reinterpretation of spatial configuration as Dalton stated; "if it is possible to split a single entry into many sub spaces or to reflect mental nature of the object" (Dalton, 2001). The first one was prepared according to the transportation map.

In the second map, coordinates of sub regions were changed to represent main arterial roads as a single line. Sub regions with undeformed transportation placed into the gridal organisation of highways to seperate local and global movement systematically.

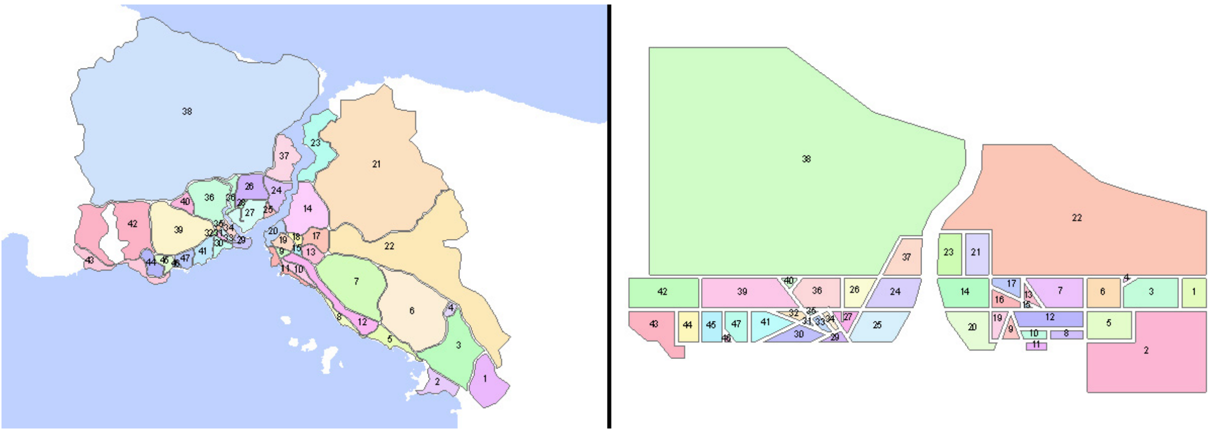


Figure 1:

Actual and transformed regions

As Figueiredo and Amorim stated, although the lines of sight are obstructed frequently by artificial environment or topography, in the dense urban areas, the lines of movement have the characteristics of continuity to work as a transportation system. (Figueiredo, L and Amorim, L, 2005) The deformed axial map of Istanbul created to overcome the problem of measuring the integration values of transportation system with main arterial roads represented as continuous lines of vehicle movement although they are not the lines of sight.

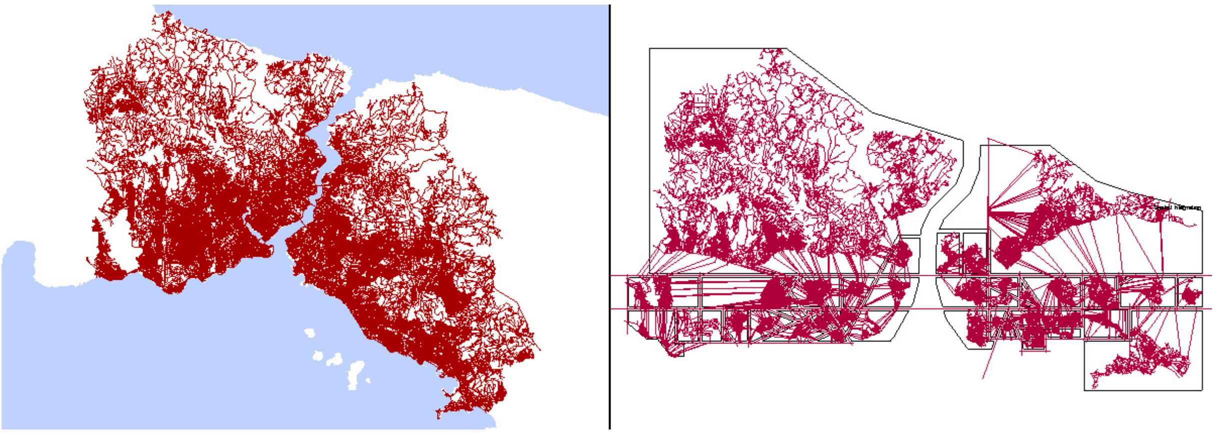


Figure 2:

Actual and deformed transportation network

These syntactic maps of the metropolitan area of Istanbul are used to forecast what changes would the third bridge might cause on the land uses. Three indicators are used for evaluating the likely effects of the third bridge proposal:

- The growth of districts in Istanbul related with the two bridges on Bosporus
- Changing location of CBD in Istanbul
- Main master plan decisions of Istanbul

The Impacts of Transportation Network on Urban Macroform

Two bridges have been built in order to perform the daily transportation between the two sides of Istanbul, first in 1973 and second in 1988. Although settling along the seashore was the main character of the city before the bridges, even after the construction of

003-04

the first bridge on Bosporus, the growth feature of the city changed from "sea dependent" to "highway dependent" growth and CBD moved through the northern side. Districts are expanded from the seashore through the northern and inner sides of the city and are currently threatening the natural regions of the city with water basins and forests.

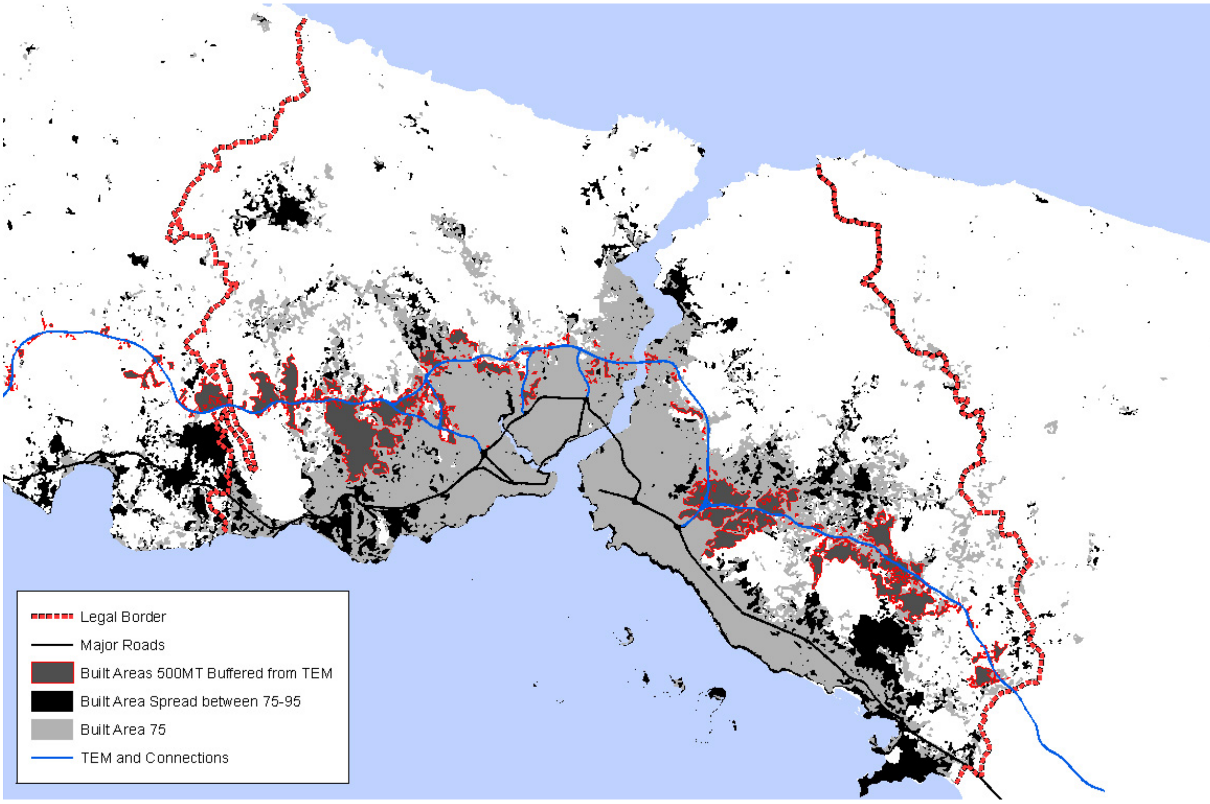
The most evident impact of the second bridge on Bosphorus, Fatih Sultan Mehmet Bridge, and the TEM highway that connects the bridge to the city can be seen in the subsequent 7 years period (1988-1995). The ratio of the settled areas of İstanbul has grown 31,8% in this term, certainly as an effect of the new bridge and the highway. The 54,2% of this expansion has been observed on the vacant areas within 500m domain of the TEM highway. Accordingly, the bridges are not only a spatial problem, but also an eyesore on the waterfront zones that was peculiar with their natural beauty. It should be noted that, the crossings over the Bosphorus are related to the transportation axes and they make a significant effect on the city structure. The two main axes that continues from the bridges, E-5 and TEM highways, have triggered the growth of the new settlement areas since many vacant areas on the north have gained access with the construction of these connections.

Urban Sprawl

Population of the city has been increasing steeply since 1950s. As shown in figure 3, this increase has created a remarkable effect on the spatial growth of the city. Dramatically increasing population and urban sprawl threaten the natural environment by pressuring the northern sides. Table 1 shows settled areas around the water basins formed after 1975.

Figure 3:

The effect of second bridge on urban sprawl



Changing Location of CBDs

With the spread of the new settlements, new sub centers have began to generate and CBD has shifted towards the north along the highways. With the two bridges, Anatolian side gained importance and attracted several functions. Some functions moved to that side from the European side, which increased the movement ratio between the two sides. In the 1970's, there were nine centers spread within the city, each with their own characteristic internal structure. In size order, starting from the largest, these centers are Eminonu, Karakoy, Beyoglu, the area between the Tunel and the Taksim square, Istiklal Street, Kadikoy, Osmanbey, Besiktas, Aksaray, Mecidiyekoy, Uskudar (figure 5). Of the districts listed, Eminonu and Karakoy can be noted as the most important CBDs of the 1970s. The CBD have expanded linearly by following the lines of topography and the level of topography has had its effect on the expansion of the CBD activities in the new areas.

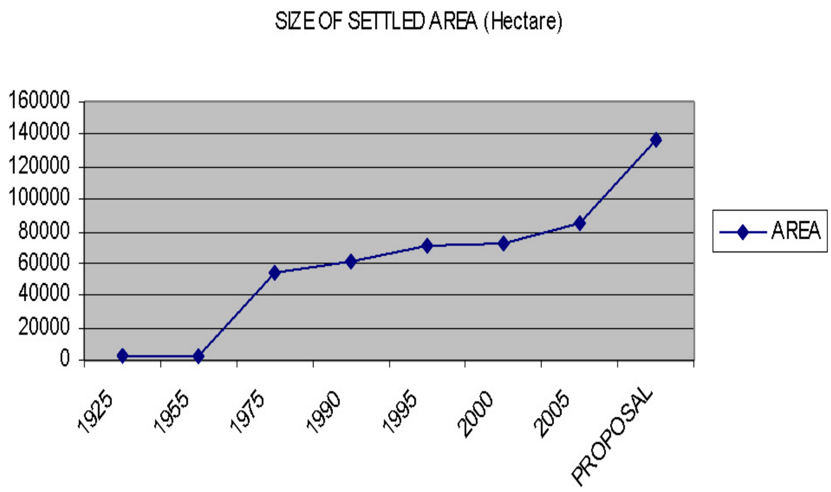


Figure 4:

Increasing size of urbanized areas of Istanbul

Table 1:

The Distribution of the Settled Areas in Water Basin Areas from 1975 to 2005

	Settlement Area (ha)			Water Basin Area (ha)
	1975	1995	2005	2005
Büyükçekmece	116,4	577,4	1060,1	9943,8
Küçükçekmece	995,8	2080	2431	5807,5
Sazlıdere	491,8	586,8	686,5	7396
Elmalı	251	510	1127,7	2836,8
Terkos	45,3	380,9	1199,9	13813
Alibeyköy	359,3	1241	1882	4642
Darlık	29,2	31,6	31,66	5232
Ömerli	1393,6	1748,8	1942,3	15137

Table 2:

The Distribution of Settled Areas, Population and Open Areas

	1975	1995	2005
Population	3849545	7196068	12018735
Settlement (ha)	53743	60866	71832
open area (ha)	461646	448739	437907

Starting from Eminonu district of the Historical Peninsula and Karakoy, CBD expanded to the area between the Tunel and the Taksim Square oriented along the main thoroughfare, Istiklal Street. Especially with the attraction that the first bridge brought to the region, the importance of Osmanbey, Sisli, Mecidiyekoy and Maslak increased as they became a part of the CBD. The main reason for the expansion of the CBD depends on the construction of the two bridges, Bosphorus and Fatih Sultan Mehmet bridges. These two passings between Europe and Asia serve not only Istanbul's inner city traffic but also European-Anatolian through traffic. The bridges have encouraged vehicle traffic and pushed the development of the new CBD to the north towards the Black sea coast. The first two bridges also have effected the land-uses and increased the population densities around surrounding neighbourds.

003-06

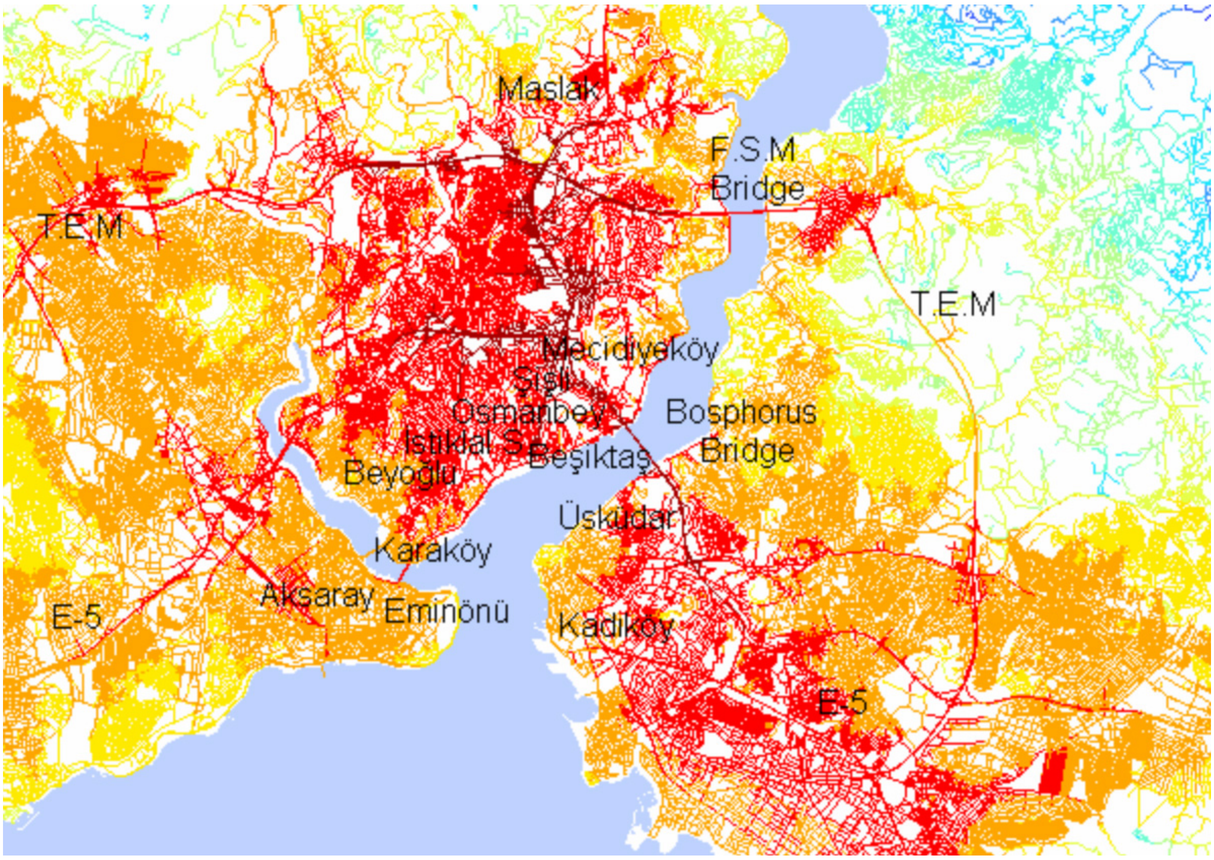


Figure 5:

The central area of Istanbul

Proposals of the Master Plan

The evolution of urban grid is determinant on movement potentials. The movement-dependent land uses, such as retail, have an intention to locate on central areas. The migration of movement-seeking land uses to movement-rich locations makes a multiplier effect on movement, and thus these locations become more attractive for land uses like retail (Hillier, 1997; Space Syntax Limited, 2002).

Within this context, the need for consideration of the new transportation network in relation to the master plan principles is obvious.

The new project proposals that are supported by the master plan constitude the significant factors effecting the city structure. The master plan, in which preserving the vital areas (forests, water basins and agricultural land) is a strict provision, includes new development areas in order to reduce the population density and provide sustainable urban transformation. However, these new settlements are proposed very close to the preservation boundaries, which thus brings out a contradiction with the aims of the plan, as recent experience has shown the difficulty of preventing the sprawl of new settlements outwards towards proposed boundaries.

The master plan decisions suggest two new alternative central locations; one in the west end and the other in the east end of the city. These proposals are expected to increase the highway trafic loads while easening the ones on existing centres. The dominant functions proposed for these centres are region-wide functions such as logistics, which requires ancillary functions and employment. Thus, these new centres might generate a threat for the vital areas.

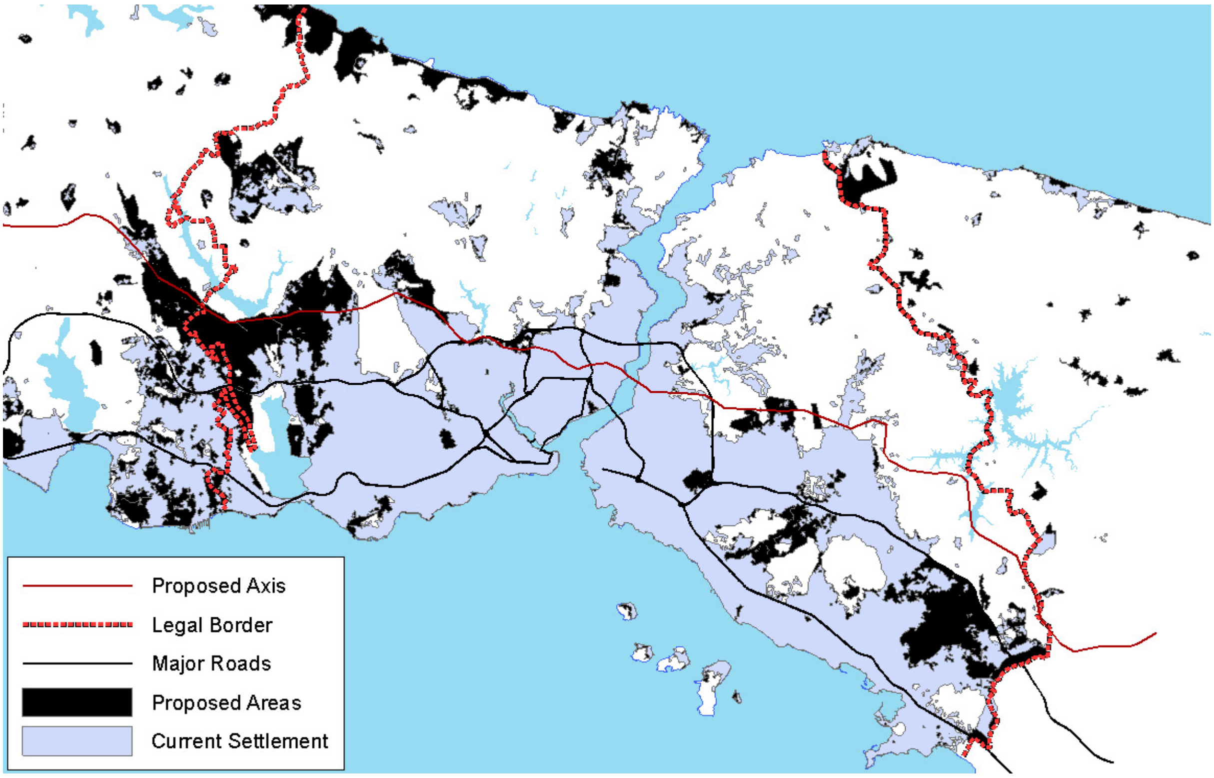
The third bridge construction recently being discussed by the public authorities proposes two alternative attitudes. One of them is

Arnavutköy- Vaniköy arterial that is proposed to be between the existing two bridges. The other alternative predominantly serves the transit traffic and passes through northern forests.

The most viable proposal for the third bridge over the Bosphorus seems to be the Arnavutköy-Vaniköy route, its being the most argued one. This route causes a deadlock for settlements, since it is proposed to be located between the two existing bridges. Furthermore, although there is no new route proposed in the north region, the proposed bridge route continues through the northern side of the TEM highway in the inner parts of the city. Figure 6 shows the existing settlement areas (shown in gray) and the proposed settlement areasprescribed in the 1/100.000 scaled Master Plan of Istanbul (shown in black). The areas in white are preservation areas, since they are either forests, water basins or agricultural land. As seen in the figure, even though the proposed bridge route is not located towards the north of the city, the proposed artery eventually passes through these areas constituting a potential threat for this vital northern region.

Figure 6:

The existing settled areas and transportation network vs. the proposed settlement areas and transportation network



Syntactic Model of Istanbul

When the integration analysis of the local structure, which is declared with the transportation diagram of Istanbul, is compared with the land use map of 2005 that displays the districts of settlements and open spaces of Istanbul, the linear development of the city is proved by the integration analyses. The E-5 and TEM roads, the major important transportation arterial roads of Istanbul, are described as the most dominant axes with their superior values. These circumstances provided the surrounding roads of these arteries to take high integration values (figure 7).

A new integration map is created via addition of the axial configuration of the third bridge on the integration map of the actual situation. This addition has drastic changes on the distribution of the integration values for the whole city. The main integration core explicitly shifts through the north and the prescribed multi-center form becomes relatively impossible. The Eminönü-Maslak axis, which is the existing CBD, spreads in the east-west directions, which also triggers the expansion of new settlements through the city peripheries (figure 8).

The most integrated line in the current transportation system is defined as an integration value of 0,18. The highest integration values generates a form containing three different linear axes; one of the two lines lying east-west direction starts from second bridge and ends in the Eyüp district; the second lying between Üsküdar and Kağıthane via first bridge; and the third axe is intersecting these two lines by starting from Maslak to the center of the Başiktaş district on the waterfront.

003-08

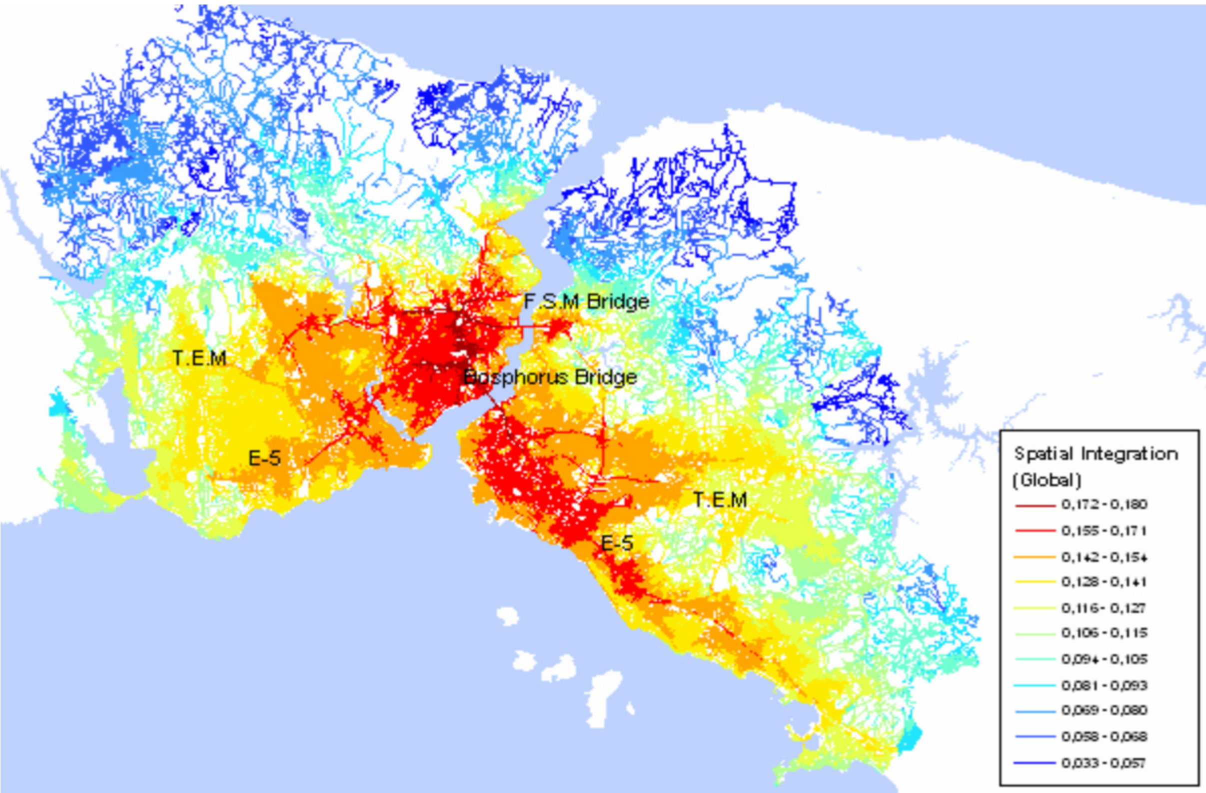


Figure 7:

Integration map of transportation system of Istanbul without the third bridge

When the third bridge proposal is added to the system, maximum integration value increases (0,22) when compared to the existing situation. In this integration map, the areas around the highly integrated lines in the current situation are expanded. With the third bridge, the line from first bridge to Eyüp district extends to Pendik in the Anatolian side, and Küçükçekmece in the European side. The mean integration value of the proposed route becomes 0,20 while the mean integration value of the whole proposed system becomes 0,139, which obviously displays the potential attraction of this new proposal.

Deformed Syntactic Map of Istanbul

The underlying spatial organisation of the urban grid is a complex structure which is neither perfectly ordered or extremely disordered. There are some rules which characterising the structure of the city, such as hierarchy and continuity. As expected, integration values are increased in the deformed axial map. According to this map, areas near to the two highways have higher integration values. The mean integration value of existing axial map is 0,22 and the maximum value is 0,35 which is higher than undeformed axial map (Figures 9, 10).

When the new bridge proposal is added to the deformed axial map, the mean integration value reaches to 0,24 and the maximum value in this map is 0,39.

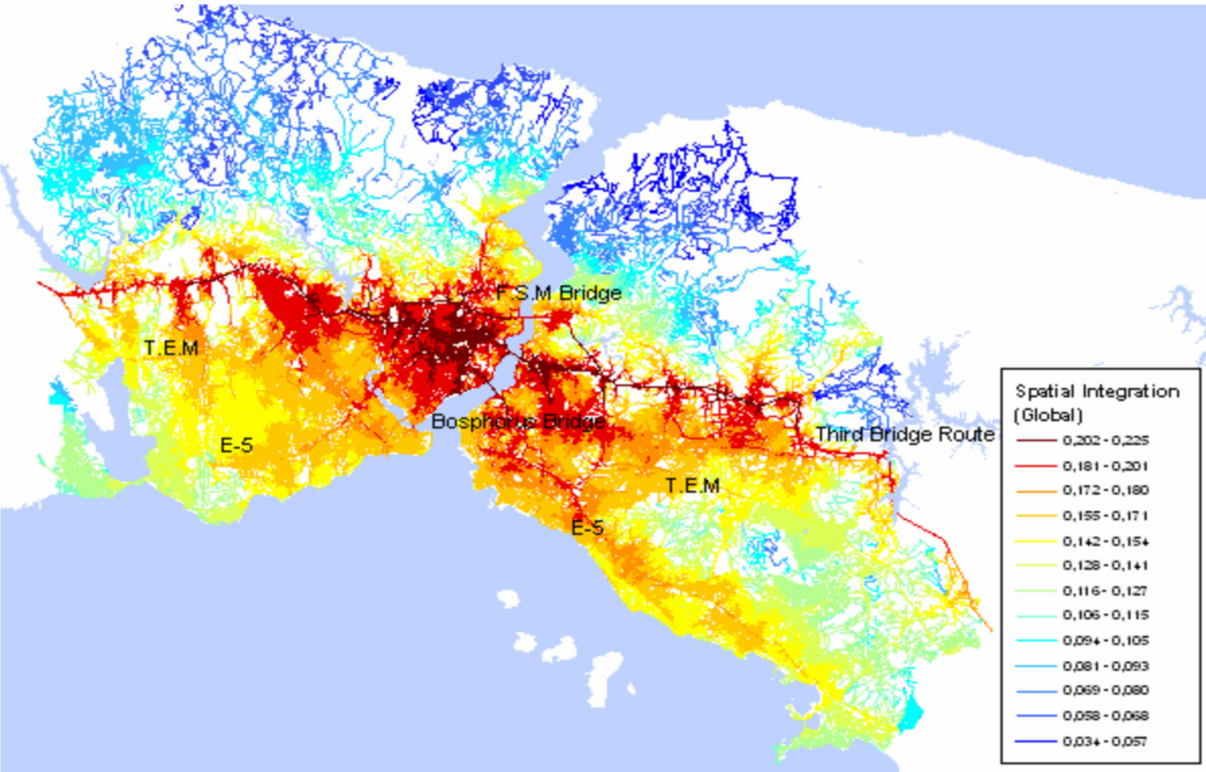


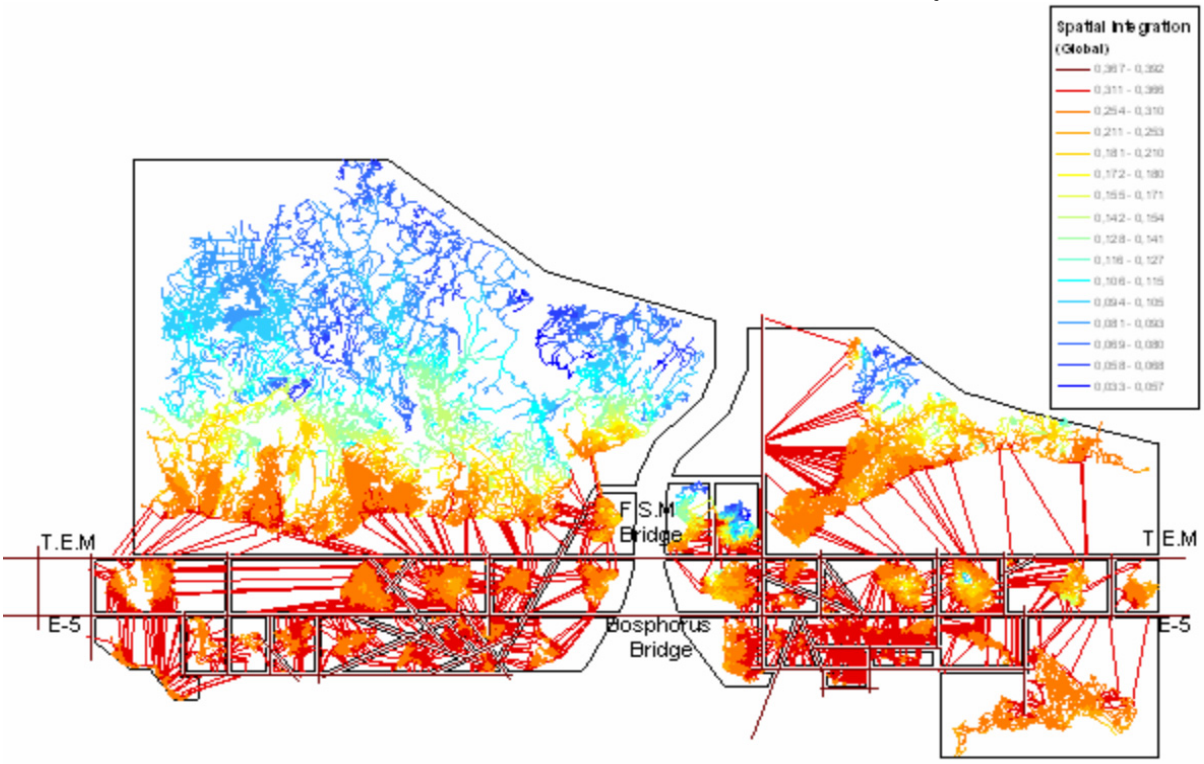
Figure 8:

Integration map of transportation system of Istanbul by adding the third bridge

Not only the integration values but also their distribution on space are changed in these deformed axial maps. In undeformed axial map, the most integrated lines are focused on Şişli-maslak region in the European side and Üsküdar, Kadıköy region in the Anatolian side. On the other hand the importance of other centers such as the Historical Peninsula and Bakırköy are diminished. Especially after the addition of the third bridge proposal on the map, their integration values are decreased.

Figure 9:

Integration map of deformed transportation system of Istanbul without the third bridge



003-10

The deformed map gives more realistic representation of the actual situation. The Historical Peninsula and Bakırköy in European side and Kadıköy and Maltepe are shown as a center added to the areas around the bridges on Bosphorus.

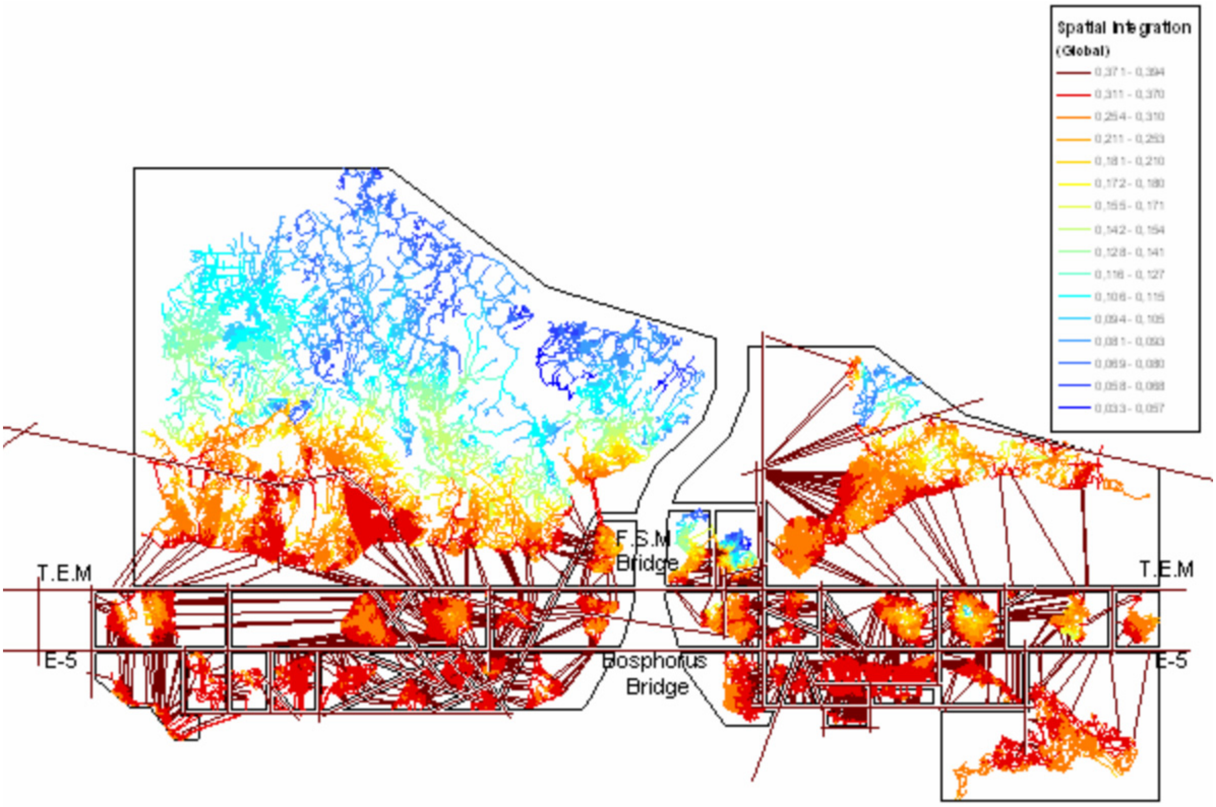


Figure 10:

Integration map of deformed transportation system of Istanbul by adding the third bridge

Probable Effects of Third Bridge

The route of the proposed third bridge displays a distinct feature by being twofold; it passes through the central area that is bounded by the two existing bridges and thus increasing the pressure in the center, while continuing through the northern side of the TEM highway in the inner parts. By this way it will possibly result on the expeansion of the settlement areas to the northern peripheries, disturbing forests and water basins.

The spatial integration analyses of İstanbul has a mean integration value of 0,13, while the mean integration value of the TEM highway (and surrounding areas) is 0,15. The second bridge on the Bosphorus that was constructed on the northern side of the city brought with itself the integration of its zone of influence, and in a short period of time caused those areas to become new settlements. The land values within the influence zone of the TEM highway have also increased proportionally with the increase in integration values. According to the syntactic analyses, this expansion of the settled areas can be explained with the high integration values of the TEM highway. Its strong connection has magnetized the integration core and accordingly its surroundings have benefited from this centralization. These analyses have a definite outcome that the integration values of the proposed transportation axes give a clue about the future structuring of the city. Similarly, the proposed third bridge on the Bosphorus and related transportation proposals will affect the land use pattern in the domain of these routes.

The spatial model of the proposed transportation network displays a new linear integration core shaped with the effect of the third bridge. This new route also effects the integration distribution within the whole system. As mentioned before, the bounds of the current CBD appear to be expanding through the east and the west. This expansion will also encourage the sprawl of new settlements in the peripheries.

This development process of the last 20 years has come to a very critical point with the proposal of a new highway crossing over the Bosphorus being put on the agenda. The river basins, forests and agricultural land on the northern sides, which are vital for the metropolitan city, have already suffered because of former progress. It is expected that the proposed third bridge and its connections are going to re-configure the future structure of Istanbul Metropolitan area, which would further have an impact on these vital regions. Therefore, such significant transportation decisions should be tested in an accurate manner before they are implemented.

Based on the previously mentioned fact that the new route will pass over the water basins and forest areas, preserving of which is a strict provision, the settlement potential of this new route is absolutely a threat for these vital areas. Accordingly, it can be said that the proposed route contradicts with the development prescribed earlier in the master plan.

Conclusion

The aim of the present paper was to examine whether the urban network affected the urban macroform. The growth pattern experienced after the two bridges has shown a strong correlation between these issues (table 1, 2).

This research clearly reveals that the existing spatial organization is succesfully represented in the spatial integration analyses of both the deformed and the non-deformed network. Thus, proposed urban networks can be accepted as indicators of the subsequent urban macroform and its outcomes.

As space syntax analyses principally focus on pedestrian movement rather than vehicular movement, a deformed network is prepared in the context of this study to evaluate the vehicular movement. This manually configured axial map expresses main motorway axes as a framework of single straight axial lines, intersecting with only the secondary arterials.

As a result of this research, we can conclude that the proposed third bridge will effect the urban macroform and land use. If the third bridge passes between two existing bridges, at first it seems to contribute to keep CBD in Maslak region while stopping growth of CBD through the north around Bosphorus. In this case, the increasing integration values show that there will be great pressure on the area between first and second bridges. This would bring traffic problems that cannot be solved and would pressure the city to grow through the northern side. The new highway for the third bridge also would attract people to settle down towards the regions of water basins and forests.

Although this study specifically focuses on İstanbul, the results have wider implication for cities that deal with the similar issue of connecting multiple massive sub-structures having few connections among each other.

References

Dalton, N., 2001, “Fractional Configuration Analysis and a Solution to the Manhattan Problem”, J., Wineman, J., Bafna, S. (Eds.), *Proceedings*, 3rd International Space Syntax Symposium, Georgia Institute of Technology, p.26.01-26.13., Atlanta, USA.

Figueiredo, L., Amorim, L., 2004, “Continuity Lines: Aggregating Axial Lines to Predict Vehicular Movement Patterns”, Proceedings, 3rd Great Asian Streets Symposium, National University of Singapore, Singapore.

Hillier, B., 1997, “The Hidden Geometry of Deformed Grids”, 1st International Space Syntax Symposium, London, UK.

Hillier B., 1996, “Space is the Machine”, Cambridge University Press, Cambridge, UK.

Kubat A S, 1990, "The Projection of Land-use in the CBD of Istanbul", Regional Science Association's 30th European Congress, Istanbul, Turkey.

Kubat A S, 1999, "The Morphological History of Istanbul", *Urban Morphology: Journal of the International Seminar on Urban Form*, 3 no: 1, 28-44, UK.

Kubat A S, 2001, “Istanbul: A Configurational Model for a Metropolis”, *Proceedings*, 3rd International Space Syntax Symposium Atlanta, USA.

Land use maps of 1995 and 2005, extracted from LandSAT images, Boğaziçi Consultant Engineering Control Inc., Remote Sensing Dept., Istanbul, Turkey.

Space Syntax Limited, 2002-a. *West Bromwitch Town Centre – Pedestrian Activity and Strategic Design* (an evaluation of current development proposals and recommendations for redesign strategy), London, UK.