The Evaluation of Co-Presence Pattern in the New Social Spaces (Case Study: Kourosh Mega Mall)

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Abstract | Throughout history, urban space has functioned as a meeting place on many levels for city dwellers. People met, exchanged news, made deals, and arranged marriages- street artists entertained and goods were offered for sale. People attended Large and small city events. Processions were held, power was manifested, parties and punishments held publicly - everything was carried out in full public view. The city was the meeting place. But today these social places are decreasing and instead new social spaces like mega shopping malls are being constructed in cities, thus making sure these spaces work properly to attract human interactions is very important. The aim of this article is to introduce new methods to understand and model human (agents) behavior and co-presence patterns.

Unfortunately, at the moment there are no good methods used in Iran to understand and predict co-presence patterns in public spaces, as a result in this article two methods, space syntax and mobile cellular data were examined based on agent based modeling theory and their role in understanding patterns of co-presence was reviewed. Then the case study of Kourosh shopping mall was analyzed through these methods. The results show that the southern part of the complex has more capabilities for social gatherings and events and also that the peak of human traffic in a day in this complex is 7 PM., the most crowded days of the week are Thursdays and Fridays and that the first and last days of the month are actually the busiest days of the complex. In the end it was concluded that these methods can shed light upon our decision making process to have better quality of life with improving new social spaces.

Keywords | Co-presence, New Social Spaces, Agent Based Modeling, Space Syntax, Mobile Cellular Data.

Introduction | Throughout history urban spaces have played an important role in enabling social interactions and therefore increasing social capital of cities and the sense of community and participation. These urban spaces are called third places in which people spend a lot of their time besides work place and homes. Today's societies need these spaces to improve social interactions and social presence crucially but unfortunately these urban spaces like the great Bazaar of Iranian cities are decaying and do not work as they did in the past as the economic and social heart of the cities where many public gathering and social events happened. As a result, social interactions are decreasing. Instead of great Bazaars, nowadays new social spaces are added to our cities that could hardly fill the absence of a powerful urban phenomenon like bazaar but are very important to study and improve their social dimension, examples of these new social spaces are the new shopping malls that are rapidly being constructed anywhere in Iranian cities specially in the capital Tehran.

Co-presence theories and understanding the patterns of co-presence is of course the key to bringing liveliness and dynamism into public spaces and our cities. Co-presence is simply the feeling of having someone around to make social contacts or at least two humans that are co-located in the same place and are aware of this situation, therefore co-presence only emphasizes on preparing the conditions of making contacts but not contact itself. Many urban planners, urban designers and sociologists have contributed to making the literature of co-presence stronger but is there any real measurement to understand why a place has the qualities of a meeting place and others don't? Unfortunately, in theoretical literature, especially in our country, there is a great gap in understanding the patterns of co-presence, and there is a vacancy in the new methods of urban spatial analysis to understand this phenomenon in theoretical literature, and therefore even in urban plans. Understanding these patterns will certainly help planners, urban planners, and architects to better understand and better predict the impact of their plans on human interaction, and ultimately choose the optimal pattern (it's worth noting that the published research by Dr. Seyed Hossein Bahreini in the book "Urban Space Analysis" about photography method to understand behavior patterns is a good basis for starting other studies). Recently a new method to simulate urban, geographical and social behaviors called Agent Based Modelling has been introduced to carefully model these phenomena like co-presence. Therefore, in this article first we review some of the most important findings about the role of new social spaces in our everyday life, co-presence in urban spaces and Agent Based Modelling (ABM), then introduce two methods to understand and simulate patterns of co-presence, first space syntax theory as a tool for crowd simulation and prediction which is based on the assumption that the spatial configuration and natural movement affect the way agents (people) move around, and second cellular data which by using the data coming from mobile phones can show us the exact patterns of co-presence in real-time and space-time. These two techniques are adapted to analyze *Kourosh* mega mall in the west of Tehran as the case study.

The Importance of New Social Spaces

Throughout history urban space has functioned as a meeting place on many levels for city dwellers. People met, exchanged news, made deals, and arranged marriages- street artists entertained and goods were offered for sale. People attended large and small city events. Processions were held, power was manifested, parties and punishments held publicly- everything was carried out in full public view. The city was the meeting place (Gehl, 2010: 25). These spaces in our cities are actually third places; according to *Borden & RuediRay* (2008) third places are any place in our lives other than work or home where we spend time and have become a non-negotiable part of the workplace experience. They play a critical role in attracting and keeping the creative and innovative workforce we will need to compete in the very near future (Borden & Ruediray, 2008: 216). Nowadays there is the increase of constructing mega shopping malls as a new phenomenon that has somehow replaced great Bazaars due to the change in customer needs and the automation of transportation. These constructions are actually one of these third places that need our attention. As Asadi (2000) stated, a shopping center (also called shopping mall or shopping plaza) is the 20th century version of Bazaar and is the offspring of industrialization and modern architecture. Shopping centers are comprised of groups of stores in a roofed/unroofed space. These centers also provide services such as restaurant, parking, recreation, hair dressing, etc. Services, to some extent, depend on the size of the facilities (Asadi, 2000: 17).

The importance of these new social spaces is that "Given the weakness of public places and consequently the weakness of social interactions, today's societies are in dire need of social spaces to increase social interactions" (Bazr Afkan & Khorrami Rouz, 2015: 13). Moreover, "Public spaces are the primary site of public culture; they are a window into the city's soul. They are an important means of framing a vision of social life in the city, a vision both for those who live there, and interact in urban public spaces every day and for the tourists, commuters and wealthy folks who are free to flee the city's needy embrace." (Zukin, 1995: 259, cited in Legby, 2013). By sharing space, we gain information and knowledge from our fellow citizens, and are enabled to participate in

processes that negotiate social structures, attitudes norms and acceptable behaviors. From this point of departure streets as well as local squares and centers appear to have a key role providing an arena for interplay between different social groups and an arena for exchanging information and are seen as crucial for providing access to opportunities and various urban resources (Legeby et al. 2015:1). The phenomenon of sharing space in public places is called co-presence in literature and this paper is looking for understanding and simulating the patterns of co-presence in new public spaces like shopping malls.

Co-presence and Understanding the Patterns of Co-presence

"Co-presence" is a sociological concept that describes the conditions in which human individuals interact with one another face to face from body to body. This concept has recently been appearing in the presence literature with increasing frequency, signaling the rise of a growing interest among presence researchers in extending presence technology to the realm of human interaction. However, like the concept of presence at its nascent stage, the meaning of co-presence in the context of mediated human communication is yet to be fully explicated (Zhao, 2004: 445).

"In the course of their daily activities individuals encounter each other in situated contexts of interaction – interaction with others who are physically co-presented." (Giddens, 1984, 64). People (or agents) become co-present as they: "[…] sense that they are close enough to be perceived in whatever they are doing including their experiencing of others, and close enough to be perceived in this sensing of being perceived." (Goffman, 1963: 17). Hanson (2000) argues that the fundamental relationship between urban space and society is not 'encounter', but 'co-presence'. Moreover, Hanson argues that co-presence (or its absence) is a generic feature of societies. Although space does not determine what takes place, co-presence is seen as a pre-condition for face-to-face interaction. This is an important social function of cities: to structure co-presence among people of different ages and genders, among inhabitants and strangers or outsiders, among people of different occupations or social classes, and within economic, civic, and religious life (Hanson, 2000; Hillier, 1996 as cited in Marcus & Legeby, 2012).

What makes co-presence such a relevant aspect from an urban design perspective is that co-presence is shown to be influenced by how space is configured; urban form is suggested to have a decisive influence on both patterns of movement and on patterns of co-presence (Legeby, 2013: 64). This hypothesis could be used to identify where co-presence might happen and understand the patterns of co-presence which will be further studied in this article. People are present in the community, but spatial configuration and in next levels, architecture and urban design can transform this "being Present" to "being co-present" by providing the conditions of making human interactions.

Crowd Simulation by Agent Based Modeling (ABM)

To this date, humans are still too complex mechanisms for computers to simulate in their entirety. However, some parts of human behavior are simple enough to be modeled algorithmically. Navigation within an environment is one of them, directed by a set of simple rules (Noel, 2005: 1). Topics in urban and architectural research are perhaps the most complex and comprehensive cross-disciplinary problems in that they involve social and human aspects and also both spatial and temporal interactions among different participating institutions (Chen, 2012: 168). ABM has found its most common use in space related topics in geospatial and urban studies. Schelling (1971) developed the first social ABM to explain the racial segregation in American cities and has enlightened ABM's wide application in related field ever since (Ibid: 169). ABM is a powerful tool that offers bottom-up understandings to complex consequences in decision-making and problem solving processes, as opposed to traditional aggregated modeling approaches. As Jennings et al. (1998) have anticipated more than 10 years ago, the ABM approach has the potential to be a "ubiquitous" modeling technology and enter the mainstream of software engineering solutions. In the past two decades since its computational realization became feasible, ABM has been applied to a wide range of topics, covering artificial intelligence, software engineering, geo-simulation, economics, sociology, ecology, etc. (Ibid: 174). Each agent can be as simple as a cellular automaton, or as complex as a human being (or the closest approximation thereof that can be built using today's knowledge and means) (Noel, 2005: 2).

In the last decades, micro-simulation models of pedestrian dynamics have been used in a wider context beyond the transportation sector, developing the capability to capture emerging phenomena resulting from the interaction between individual features and collective behavior, also exploiting the potential of several new approaches and techniques, such as physically inspired models, cellular automata and agent-based modelling (Pluchino et al. 2014: 2). When humans are assembled into a crowd, the way each individual interacts with the environment and the other members of the crowd remains unchanged, from a navigational standpoint. However, observed at a macroscopic scale, the crowd as a whole can exhibit emergent behavior (Noel, 2005: 1). Crowd simulation is

any simulation attempting to model the behavior of a large number of agents, and their interactions with each other (Ibid: 2). The spatial configuration of a building and its spatial complexity may affect visitors' movement patterns, orientation, and wayfinding behavior (Omer & Goldblatt, 2016: 1). Thus, in any case, the simulation can be separated into 2 entities: the agents and the environment in which they evolve (Noel, 2005: 2). Therefore, in order to model the behavior of a human being as closely as possible, an ideal agent should consider the environment it is navigating as continuous, recalculating its trajectory in real-time to acknowledge the changes in topology and the movement of other agents (collision detection and avoidance) (Ibid: 16).

Previous studies have suggested two sets of spatial characteristics of a shopping mall that may influence movement patterns: the spatial configuration of the setting, and the quality and spatial organization of its content, i.e. the type of stores and other attractors, as well as various architectural design characteristics (Omer & Goldblatt, 2016: 3).Therefore, the important thing to remember when simulating crowd movement in new social spaces is the effects of spatial configuration on human behavior. Space syntax theory is one that takes this hypothesis into account.

Adopting Space Syntax theory to Model Human Behavior

Space Syntax is an analytical tool in architecture and urbanism introduced first by Hillier and Hanson colleagues at The Bartlett, University of London in the late 1970s to early 1980s as a tool to help architects simulate the likely social effects of their designs. Space syntax theory was published by Hillier and Hanson in the book "The Social Logic of Space" in 1984 but the analytical method was developed in the book "Space Is the Machine" in 1996. By using Space Syntax method, analysis of urban spaces and interaction with other spaces and public use of urban spaces are feasible. This method can predict the effects of urban changes in urban spaces. Therefore, it can help designers and urban planners to design optimally. (Abbas Zadegan & Azari, 2009: 26). In space syntax theory, co-presence is seen as an important social resource, and the potential to develop social networks and different social solidarities has been said to pass through the relation of spatial configuration and co-presence (Hillier ,1996 as cited in Legeby, 2013). It has even been argued that an important social function of a city is to structure co-presence among people from different social categories—and that the effects of urban design are pervasive and insistent and by nature never absent (Hanson & Hillier, 1987 as cited in Legeby, 2013).

Several studies have pointed to the effects of visibility and accessibility on movement patterns, route choice, and decision behavior in shopping malls, culture centers, galleries and museums, conference centers and university buildings. Route choices and movement patterns were found to be related to various design factors, graphic and audible components attractors and movement generators, transition spaces between floors, as well as previous experience and familiarity with the building's layout (Omer & Goldblatt, 2016: 4). Also as *Jan Gehl* concluded in his book *Cities for People* (2010), if we look at the history of cities, we can see clearly that urban structures and planning influence human behavior and the ways in which cities operate (Gehl, 2010: 9). To sum up, it could be said that space syntax is the theory that can predict agents' behavioral patterns by natural movement law and analyze the spatial configurations that social interactions and human movement happen in. But this model also has weaknesses in this regard, including the lack of consideration of spatial functions such as land use, culture, human characteristics, as well as the important topic temporal behavioral patterns. Space syntax in its analysis focuses solely on spatial configuration and cannot take into account the difference between a residential land-use and an activity that attracts population, like commercial land-use; cannot understand cultural and human characteristics that may vary in any society and affect interactions, such as personal domains and also cannot differentiate patterns of behavior in a specified space at different times, such as night, day, different days of the week and holidays, and so on. As a result, new methods that can be used to recognize these secondary factors should be adopted to better understand co-presence patterns.

Using Cellular Data as a new method to better understand human behavior

Recently, Massey, Thrift and others have suggested that our focus must be on 'time-space' or 'space-time'. Massey (2005), in particular, has outlined how space and time 'are integral to one another', 'distinct' but 'co-implicated', and 'it is on both of them, necessarily together, that rests the liveliness of the world' and she has convincingly argued that relational approaches to time-space can enable us to reconnect the spatial with the political, as well as forming the basis for dialogue between human and physical geographers (Massey, 2005 as cited in Merriman et al., 2012). Using cellular data because of its big amount of data of the 24 hours a day by each person that uses mobile phone is a new way of analyzing human behavior in space-time. This kind of data is more reliable and factual because in today's societies especially in cities, almost everyone uses cellphones. Additionally, Ratti et al. (2006) concluded that Results seem to open the way to a new

approach to the understanding of urban systems, which we have termed "Mobile Landscapes." Mobile Landscapes could give new answers to long-standing questions in architecture and urban planning - How to map vehicle origins and destinations? How to understand the patterns of pedestrian movement? How to highlight critical points in the urban infrastructure? What is the relationship between urban forms and flows? And so on. The traditional approaches to gaining information about these issues are very costly. Traffic engineers still use extensive (and expensive) surveys to calibrate their models. Space syntax researchers (Hillier, 1996) carefully monitor pedestrian movement in order to gain insight on its correlation with urban configuration. Both fields could be revolutionized by the introduction of Mobile Landscapes, as they would reveal in real time actual patterns of movement rather than models or estimates (Ratti et al., 2006: 2).

"Mobile networks, traditionally referred to as 'cellular' networks, consist of 'cells'. Cells are essentially geographic radio frequency (RF) signal serving zones around a tower or base station. Each cell within a cellular network is geographically defined by the range that RF signals propagate to continuous space. When a mobile phone user is moving and enters a serving cell, network base stations are designed to recognize that the user is within the serving proximity of the station's neighborhood. The base station then automatically 'locks on' to the mobile, and 'hands off' the call from one base station and corresponding cell to the next base station and serving cell within the network." (Spinney 2003, as cited in Ratti et al., 2006) Although Outdoor localization has reached some maturity with Global Navigation Satellite Systems (GNSS) but Due to a weak and partially absent satellite signal indoors, other methods have been developed for indoor localization (Naderi, 2012: 1). In this article an in-building signaling system is used to gather movement data which cannot locate the exact location of the mobile users and can only tell us how much movement happens during a day, a week, a month or even hourly which is very important to identify the patterns of co-presence in social spaces.

Modeling Patterns of Co-presence in Kourosh Mega Mall

Kourosh mega shopping mall is a new constructed complex in the west of Tehran. It has ten stories and many land-uses other than commercial like restaurants and cinemas. It is actually one of the biggest malls in the country and attracts many citizens during the day,

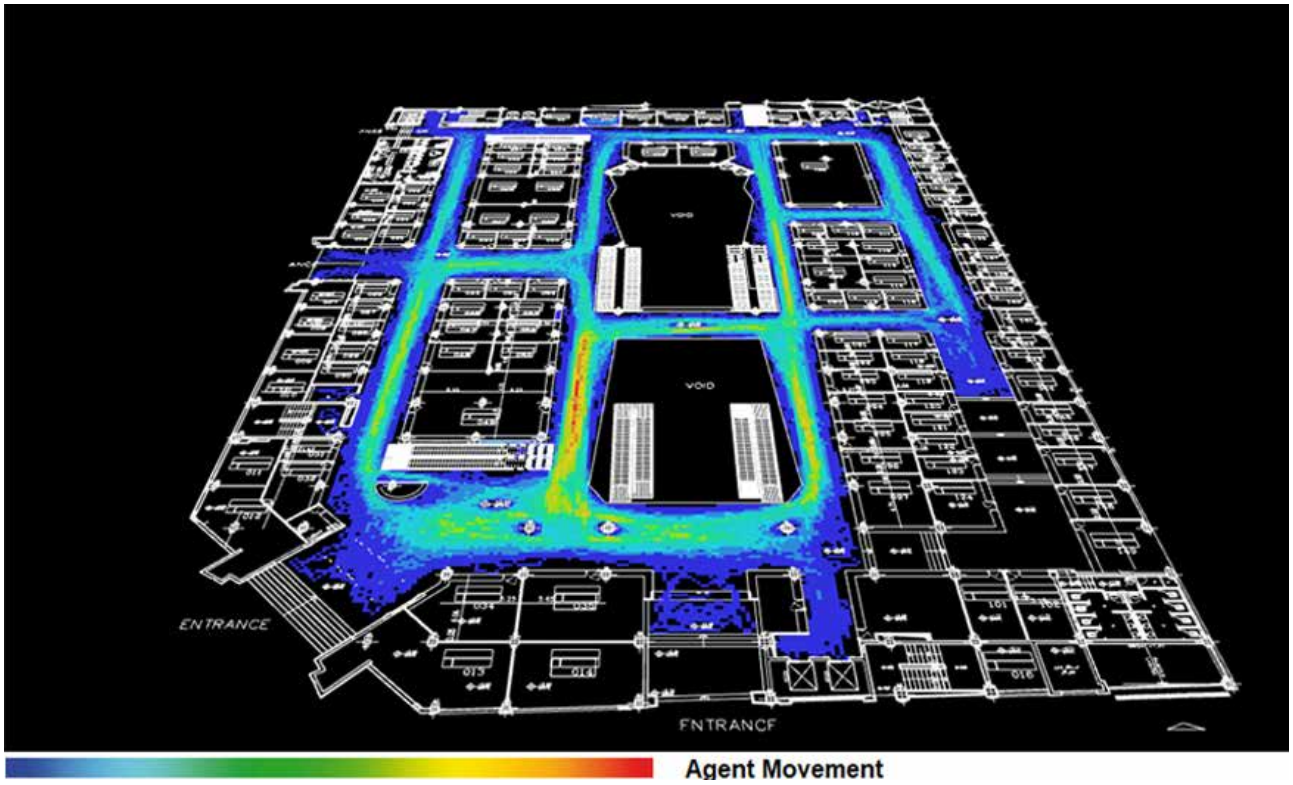
Pic 1: Aerial photo of Kourosh shopping mall.
Source: author based on www.googleearth.com

thus understanding the patterns of co-presence in this complex is very important and will help us better manage it especially in times of unfortunate events like earthquake that the crowd show irregular behavior and maybe even plan for different social gatherings in special spaces (Pics 1-3).

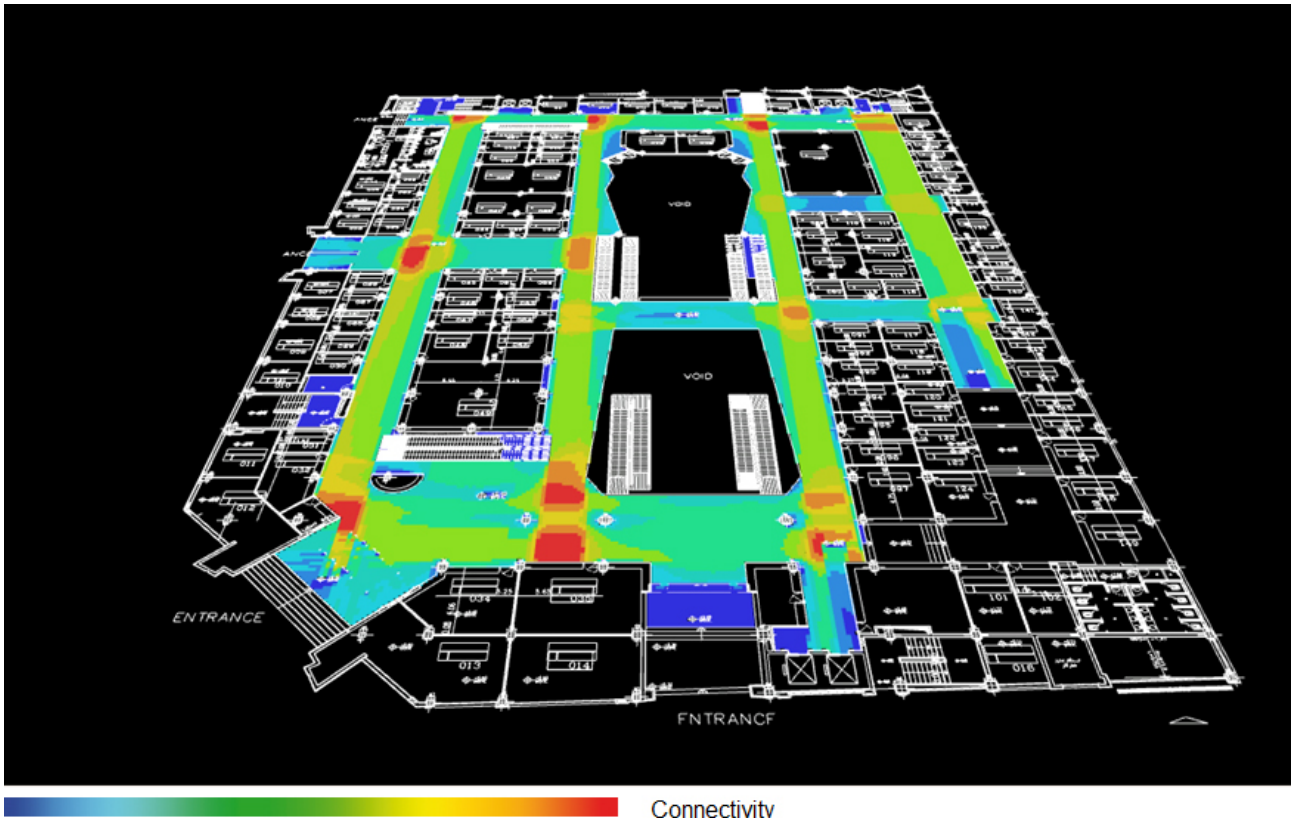
As mentioned before in this Article the patterns of co-

Pic2: Inside view of Kourosh shopping mall.
Source: http://iransublet.com/blog

Pic3: View from outside to Kourosh Complex.
Source: : http://econews.com/fa/content/1057178



Pic4: Agent Movement Map of Ground Floor (3D View), red color shows highest possibility of co-presence in space and blue color the lowest. Source: authors.



Pic5: Connectivity Map of ground Floor, red color shows highest connectivity (encounter possibility) in space and blue color the lowest. Source: authors.

presence are modeled with two methods first with the space syntax theory and second with using cellular mobile data. Therefore, in the space syntax theory the segment map of the complex was analyzed using depth map software. This software actually models the behavior of actors (crowd) using the laws of natural movement and the configuration of space.

The results show the following maps, Pic 4: Agent Movement Map of Ground Floor (3D View) shows that the south of shopping center has more capability of co-presence as there is warmer colored spots in the map and the corners of the mall where most of the spots are blue colored have less capability of co-presence and could probably be the victim of pick-pocketing and other harmful behaviors like vandalism because there is less natural control by the crowd. Pic 5: Connectivity Map of ground Floor illustrates the connectivity map of ground floor. It is clear that the intersections have more connectivity and the interesting fact is that because of the configuration of space the south of the mall has the most capabilities for human interactions and social gatherings. Of course, it should also be noted that the map of Kourosh building in the different stories is almost identical, and therefore, considering that in this study, only internal spatial interactions are taken into account and the entrances have no impact on the results, only the analysis on the basement is illustrated.

The second method to examine the patterns of co-presence is using cellular mobile data. This method analyzes crowd behavior in real-time and examines the co-presence after it has happened whereas space syntax is just able to simulate where the patterns of co-presence might happen in the future. Another benefit of mobile cellular data is that these huge amounts of data can be browsed by 24 hours of the day and 7 days of the week and even months. With this big data many analyses as to why, where and when the patterns of co-presence happen could be calculated. In this study unfortunately because of the lack of more advanced signaling technology in the building we could not identify the exact location of mobile users and only general statistics about when the users visited each floor and their overall number were at hand. The Results are illustrated in the Diagram below. Diagram 1: Mobile Traffic in Kourosh Shopping Center (Daily) shows the crowd in different times of the day in different floors, it is obvious that there are two main peak hours in Kourosh complex one in the 13 PM and another in 19 PM. Other factors also affect the patterns of co-presence that are addressed in the previous sections. As shown in the graphic below, these factors cause the co-presence pattern to be different in stories of the building; using cellular data can show this difference as a result of having huge amount of real-time data, but space syntax method cannot differentiate co-presence in stories of the building specially because of identical map layout and only takes spatial configuration into consideration.

Diagram. 2: Mobile Traffic in Kourosh Shopping Center (Daily)-from 30 Jan-5 Feb 2017 (one week) and Figure 3: Mobile Traffic in Kourosh Shopping Center (Daily)-from 2 Jan-5 Feb 2017 (one month), show that Thursdays and Fridays are the most crowded days of the week in Kourosh shopping mall and Saturdays are the least crowded and also that the first and last days of the month are the most crowded.

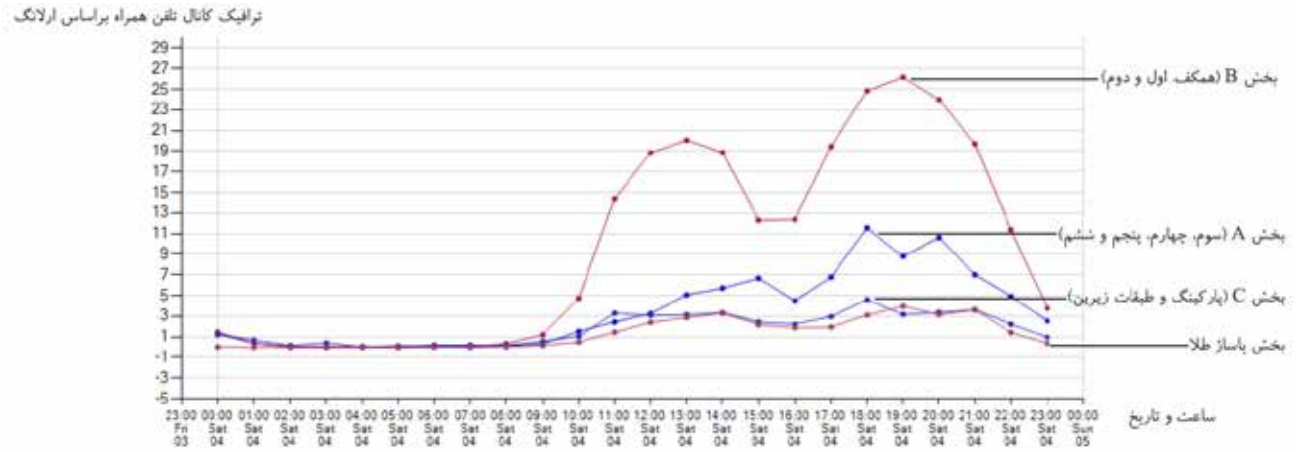


Diagram 1: Mobile Traffic in Kourosh Shopping Center (Daily) - showing 24 hours of a day.
Source: authors.

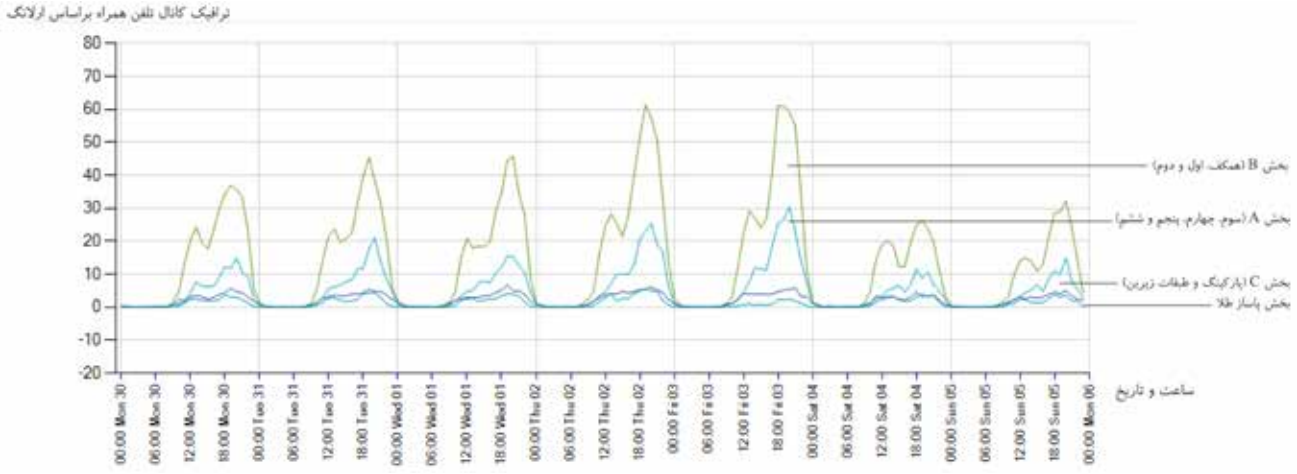


Diagram 2: Mobile Traffic in Kourosh Shopping Center (Daily) - from 30 Jan5- Feb 2017 (one week).
Source: authors.

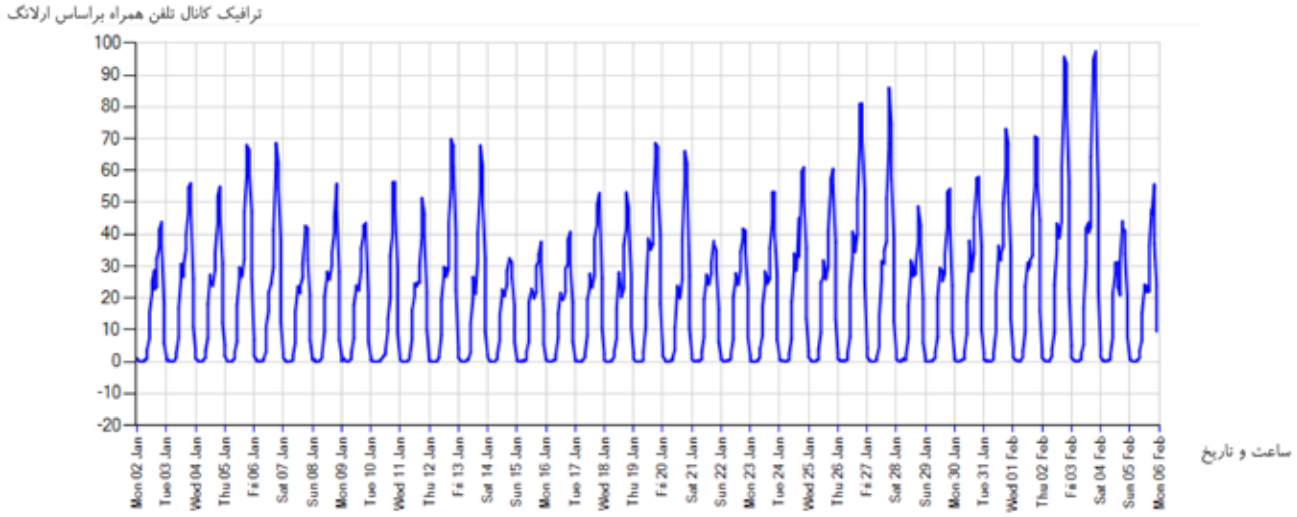


Diagram 3: Mobile Traffic in Kourosh Shopping Center (Daily) - from 2 Jan5- Feb 2017 (one month)- this chart shows the accumulated result of all the four sectors.
Source: authors.

Conclusion | In this article, first the importance of co-presence in new social spaces and modeling patterns of co-presence was examined and then two agents based modeling methods of space syntax and mobile cellular data were introduced. In the end, these methods were analyzed on the case study of Kourosh mega shopping mall. The results of this study are summarized as follows:

• One of the ways to understand human behavior is by agent based modeling which has gained great importance in recent years.

• The configuration of space has great impacts on social interactions and the behavior of agents (people). But as the difference in presence in the various stories of the Kourosh Complex showed, configuration is not the only factor and other factors also affect the patterns of presence.

• Space syntax is a method to analyze crowd traffic and possible patterns of co-presence in urban spaces but this method cannot analyze factors like, land-use, culture and time; therefore, the necessity to have supplementary methods is completely clear.

• Agent-based modeling can show us the results and effects of different design scenarios and prevent making mistakes in urban planning, design and architecture. For example, as we know, people display abnormal behaviors when natural

disasters happen that may be risky, by modeling movement patterns in a crisis; design can be optimized to improve safety. Or, for example, in analyzing traffic congestion the impacts of land-use change according to the movement of agents in space can be predicted and in case the results show an increase in the congestion, there could be an addition to the capacity of the streets in design and planning phases. These predictions could be done in a small scale (architecture) or a larger scale (urban planning and design).

• The results of modeling co-presence in Kourosh Mega mall show that some places like the southern part of the building have great potentials for co-presence and informal public gatherings (according to the color difference in figure 4).

• By using this method, the patterns of co-presence in internal spaces of shopping malls could be identified and managed consciously and smartly.

• Temporal crowd behavior in Kourosh complex shows different patterns of co-presence during the hours of the day, days of the week and month. Thursdays and Fridays are the most crowded and Saturdays the least crowded days of the week and the first and last days of the month are more crowded than normal days.

• The use of mobile data can be effective in order to better understand agents' real-time behaviors in the social and public spaces, urban transportation and of course buildings in a timely and accurate manner, and then to predict future trends. For example, as it was revealed at the end of this study, Thursdays and Fridays are normally the busiest days of the week at the Kourosh Complex, therefore, it could be expected that this trend will be the same throughout the year, other than specific days like the Nowruz. As a result special traffic measures around the complex, in particular the Sattari Highway, could be taken to prevent traffic congestion.

In the end it should be said that this study illustrates some of the methods of analyzing and modeling co-presence in social spaces which could be used to better design, locate and manage the new social spaces.

Endnote

1. An *Erlang* is a unit of telecommunications traffic measurement. In practice, it is used to describe the total traffic volume of one hour.

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