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# Visiting Index: Supporting decision-making on Open Urban Spaces

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#### **Keywords:**

decision-making, open urban spaces, visiting parameters, dynamic relations

#### **Abstract**

This Open urban space functions as the stage of the city where public life unfolds. These spaces, which provide traffic networks, communication nodes and common spaces for play and relaxation and play a key factor in shaping cities and enhancing urban resilience. Forming and planning urban spaces is a complex and demanding process and, in many cases, the final approved proposal lies upon city decision-makers. Supporting stakeholders to approve plans and regeneration actions creating desirable open spaces, corresponding to urban living needs, seems crucial. In this framework, the research focuses on identifying the priorities of the decision-making prosses and citizens' preferences on open urban spaces. In addition, the way in which citizens' preferences define the number of their visits to an urban space is investigated in order to develop a model estimating Demand side on open urban spaces. As the parameter of Supply of open urban areas should not be ignored in this process, the Visiting Index is developed as the key performance indicator to be under study by stakeholders. At last, considering that urban areas are complex, dynamic systems evolving rapidly, the dynamic relationships among the parameters of Visiting Index are described in Casula Loop Diagram to contribute to making open urban spaces effectively manageable.



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#### 1. INTRODUCTION

Open urban spaces are key elements of the built-in environment. Within the urban fabric, they are spaces that can host a variety of physical activities, provide many important benefits for citizen's life and serve a variety of functions that improve the quality of life in cities (Coutts et al, 2013). In urban planning and landscape studies, the quantity and quality of outdoor urban spaces in a city are under several attention (Mougiakou & Photis, 2014). A well-designed open space that encourages outdoor activity and social interaction is a community benefit that could potentially contribute to the health of locals and the social harmony of the community. Many factors can affect the use of any space and can lead to attract a bin number of visitors.

Open spaces are essential to support citizens' outdoor activities and public life, which in turn help them to reduce stress and provide them opportunities for relaxation (Grahn & Stigsdotter, 2003). Many dynamic factors and complex interactions determine the attractiveness open spaces and citizen's decision to visit and stay in a public space (Tzoulas et al., 2007). For example, the spatial configuration of parks, their size and accessibility determine the possibility to be uses by people (Zhang et al., 2011). In specific, the accessibility of outdoor urban spaces is considered the most important factor influencing their use (Peschardta et al., 2012). Distance from 300 to 400 meters for an open space is considered an important limit. Specifically, when the distance is greater than 400 m, the frequency of use is significantly reduced (Badland et al., 2014).

In addition to accessibility, the factors that affect the use of open spaces vary and are closely related with their design and the services that provide. The features of the open spaces themselves provide information on the uses they may or may not accommodate. For example, Cortis (1996) observes that the use of parks is influenced by their aesthetic characteristics, the presence of comfort elements and the size/area that cover. Moreover, there are positive correlations between the use of outdoor areas for physical exercise and the existence of vegetation/greenery, water elements, pleasant views and parking spaces (Schipperijn et al., 2013). Giles-Corti (2004), who used the concept of "attractiveness" to examine the relationship between open spaces and walking, found that people with good access to attractive open spaces were 50% more likely to use it for walking. Finally, Goličnik and Ward Thompson (2010) reported that the design of a small additional space, which allows appropriate supporting zones, e.g., for parking or public safety, is an important aspect that should be considered in the design of public space as it works positively for citizens to visit.

Existing data show that users generally prefer close, large and attractive open spaces. However, the impact of accessibility and the scale of the open space remains questionable. If these differences could be ignored and emphasis placed on the open space itself, the characteristics influencing the use of open spaces are crucial to the final decision (Chen et al, 2016). The identification of the characteristics of these outdoor urban spaces that attract users to come and stay in them and the correlation of the factors but also the degree that determine the decision of the users is under study. Main objective of this study is to support stakeholders with the decision-making process of urban regeneration actions/plans in open urban spaces.

## 2. THEORETICAL BACKGROUND

## 2.1 Decision-making Gap

In practice, monitor and evaluation are a necessary stage of any urban regeneration action/plan. The data emerging from these processes provide a crucial source of information for the decision-making process and for the management of these projects. Monitor refers to collecting the basic data and the measurable characteristics that exist in an urban area that show the current situation of the area. Evaluation refers to the measurable qualitative and/or quantitative scoring and classification of the actions based on the changes and the results that bring in relation to predetermined goals of the urban regeneration. It is a "multiple system that deals with the planning decisions, goals and objectives that have been set and the assessment of the impact on society and on the function of a city in general."(UNEP, 2004).

In recent decades, a number of decision support tools have been developed by private and public initiatives to help the involved parties to monitor and assess the performance of urban areas (Bartzokas-Tsiompras et al., 2020; 2021; Bartzokas & Photis, 2019). Amona the European Union Initiatives, the Urban Data Platform plus is the most updated. UDPplus is a joint initiative of the JRC and DG REGIO. It provides a 360 degrees overview on the status and trends of European cities and regions. It aims to aid decision-makers, policy analysts and other stakeholders in monitoring/analysing cities and urban areas in certain thematic fields, in achieving robust analyses with tables, graphs and maps and in reaching/acquiring data for a large set of cities. UDPplus provides access to statistical and modelled indicators covering the following topics: Economy, Education, Environment and Climate, Governance, Health, Employment, Energy, Development, Population Dynamics, Research & Innovation, Security, Social Issues, Transport and Accessibility while the data are available at the following geographical levels: Cities/Greater Cities, Urban Centres (worldwide), Functional Urban Areas, Metropolitan Regions (European Union, 2017).

In addition, the Cultural and Creative Cities Monitor is designed to help national, regional and municipal policy makers identify local strengths and opportunities and benchmark their cities against similar urban centres using both quantitative and qualitative data. This platform allows users to browse the 168 selected cities and the quantitative and qualitative information about their performance (European Union, 2017). At the same time, The Global Human Settlement (GHS) framework produces global spatial information about the human presence on the planet over time. This in the form of built-up maps, population density maps and settlement maps. This information is generated with evidence-based analytics and knowledge using new spatial data mining technologies. The framework uses heterogeneous data including global archives of finescale satellite imagery, census data, and volunteered geographic information. The data is processed fully automatically and generates analytics and knowledge reporting objectively and systematically about the presence of population and built-up infrastructures (European Union, 2010). At the same time, the ITF (International Transport Forum) Urban Mobility has set a new Urban Access Framework together with the European Commission and the Organisation for Economic Co-operation and Development. The framework is used to measure accessibility in 121 cities in Europe (OECD. Stat, 2017).

The tools described even if they provide valuable data for cities' stakeholders in general or for specific sectors of the urban life, they abstain from providing information in specific for public urban spaces or form proposing a methodology to incorporate the provided data in the decision-making process for the urban planning and the future of cities. Stakeholders need to prioritize the parameters that define citizen's behavior regarding urban spaces in order to incorporate user's needs in the decision-making process. Citizens' preferences should be considered regarding urban regeneration plans/actions as public urban spaces exist to serve people and their success is related to the user's appropriation.

Based on this gap, the current study focuses on supporting decision-makers for open urban spaces by identifying citizen's needs and preferences regarding the open urban spaces as well as the way and the level in which these parameters define citizens' visit to these spaces. In addition, the Visiting Index is developed to monitor and assess the performance of an urban regeneration plan for these spaces while the dynamic relations among the factors of the index are described too.

## 3. METHODOLOGICAL APPROACH

At first, for identifying users' needs and preferences, questionnaires were developed and addressed to Patras' citizens with various backgrounds to understand the main factors that define their decision to visit and stay in an open urban space as well as discussions-interviews were made with local stakeholders and municipal representatives.

Secondly, among the different statistical analysis methods, such as Principal Component Analysis (PCA), Accounting or Logistic Regression, the Linear Regression model is chosen to determine the relationship between the visit variable (dependent variable) and independent variables. The purpose of estimating the relationship of these variables is to study whether and in which level the values of the dependent variable are affected by the values of the independent variables.

At least, the causal loop diagram (CLD) that describe the dynamic relationships among the factors of the Visiting Index is developed. The CLD helps to illustrate how the various variables in the system of Visiting Index interact. The diagram consists of a set of nodes and edges. A link marked positive indicates a positive relationship and a link marked negative indicates a negative relationship. A positive causal connection means that the two nodes change in the same direction, ie if the node to which the connection starts decreases, the other node also decreases. Similarly, if the node to which the connection starts increases, the other node also increases. A negative causal connection means that the two nodes change in opposite directions, that is, if the node to which the connection begins increases, the other node decreases and vice versa. Closed circles in the diagram are very important features of CLD. A closed loop is defined as either a reinforcing or balancing feedback loop. A negative loop is the cycle in which the result of a change in any variable is propagated through the loop and returns to the variable a deviation from the original, i.e. if a variable increases in a balancing loop the result through the loop will return a decrease in the same variable and vice versa. These cycles are self-balancing loops that tend to seek and maintain a level (Meadows et al., 1972).

#### 4. WHAT MAKES AN OPEN URBAN SPACE DESIRABLE?

## 4.1 Citizens' and expert opinion

Questionnaire results show the preference of users in open public spaces instead of closed ones, mainly because they have green spaces, provide the feeling of comfort, coolness and freedom. Users seem to prefer open urban spaces as places of socialization and group activities too. Citizens use these spaces mainly for walking, relaxation, sports activities and social activities to a greater extent and less for business purposes. It is found that the public spaces of the are used mainly as traffic/passage areas instead of stopping places in even if they will prefer an open space that attracts them to stay for hours.

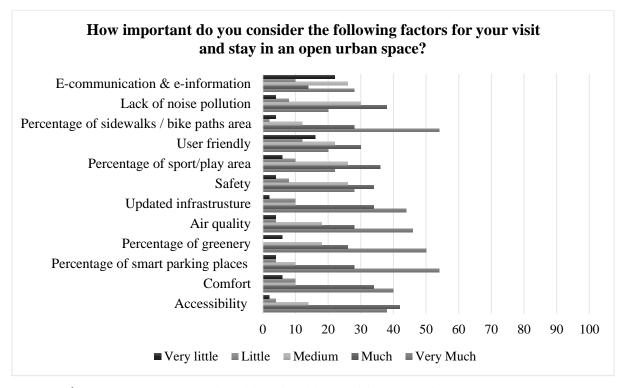


Diagram 1. Factors that define citizens' decision to visit and stay in an open urban space

The factors that influence the choice and preference of users to visit and stay in an open urban area are, mainly, the percentage of greenery, the percentage of sidewalks / bike paths area and whether there are smart parking spaces. In addition, users seem to be interested in the quality of the air and the level of safety that prevails in these areas. At last, they prefer spaces with access to the internet and electrically interconnected and updated infrastructure (Diagram 1). In total, 150 citizens answered the questionnaire: 42% women - 68% men, 21% aged 18-25, 28% aged 25-40, 31% aged 40-60, 20% over 60. From the interviews with Patra's decision makers, there was evidence for lack of a concrete process for urban regeneration decisions; such decisions almost entirely depend on the existence of the appropriate financing tools. In their opinion, monitoring the changing urban state through indicators is critical; among these, "citizens' demand to visit an urban space" is the most indicative. Regarding the process of selecting an implementation plan, it is stated that,

"There are no fixed criteria, and the decision process depends on the criteria that each architectural contest or municipal stakeholders declare. Unfortunately, most criteria are based on the economic competitiveness of an offer and not on the technical excellence of that offer."

The majority of the stakeholders is positive on the need for developing a methodological framework for assessing urban solutions for regeneration plans. They rank green spaces, *mobility* and the *upgraded connected infrastructure* as the main factors that should be considered in the decision-making process too.

## 4.2 Model for estimating visits on open urban spaces

Designing and creating spaces that attract the attention and interest of citizens and in which the user feels that he can stay and be active should be a key priority in the decision-making process. It is therefore of great importance to study the relationship between the number of visitors and site features and in the present study, this relationship is examined by creating a regression model. Through questionnaires, the main factors that lead users to visit an outdoor urban area were identified (Diagram 1). This was done through the questionnaires made available to the citizens of Patras. Of these factors, the following were the most critical: percentage of greenery, percentage of sidewalks / bike paths area, percentage of smart parking places. For these main factors and for determining the degree to which they increase or decrease the traffic of citizens in an open urban space, given scenarios for evaluation were provides to users. Specifically, the question posed to the citizens was:

At what rate would you multiply the number of visits made in a period of three months, compared to the current ones, to an outdoor urban area depending on the percentage of greenery, the percentage of sidewalks/bike paths and the percentage of intelligent parking spaces offered on it?

The prices that the citizens can choose are from 1 to 5. The scenarios were evaluated by 150 citizens and the results were used to derive the regression model. Based on the results, the following relationship emerged:

$$A = 0.003808684 * x_1 + 0.007356411 * x_2 + 0.008545393 * x_3 + 1.858052686$$
 (1)

Where x1= percentage of greenery area, x2= percentage of sidewalks / bike paths area, x3= percentage of smart parking places and A= multiplication rate of visits in 3 months. Based on the regression model, which calculates the multiplication rate of citizens' visits per quarter depending on the three most important factors that determine the user's decision to visit an outdoor urban space, it is possible to calculate the traffic that an outdoor urban space will receive after regenerative actions, according to the relationship

$$Y'=A*Y$$

Where Y is the current traffic of citizens in the outdoor urban area in a period of three months, A is its multiplication rate and Y' is the estimated number of visits in three months after regeneration actions. Indicatively, the developed model is applied in the central open space of Patras, Pier of Saint Nicolas. Given that currently the area receives Y = 11,700 visits in 3 months (estimation from the questionnaires), the estimated visits



that the space will reach, based on different values that the parameters of the model can get after regeneration actions, are presented in Table 1.

Table 1. Estimated visits in 3 months for the case study area based on different values of the parameters

	•	•	• •	, ,
Percentage of greenery area (x1)	Percentage of sidewalks / bike paths area (x2)	Percentage of smart parking places (x3)	Multiplication rate (A)	Estimated visits in 3 months period (Y)
0	0	0	1,86	21762
20	0	0	1,93	22581
40	0	0	2,01	23517
0	0	20	2,03	23751
20	20	0	2,08	24336
60	0	0	2,09	24453
40	20	0	2,16	25272
80	0	0	2,16	25272
0	0	40	2,20	25740
20	40	0	2,23	26091
60	20	0	2,23	26091
20	20	20	2,25	26325
40	40	0	2,30	26910
80	20	0	2,31	27027
40	20	20	2,33	27261
0	0	60	2,37	27729
20	60	0	2,38	27846
60	40	0	2,38	27846

#### 4.3 Assessing the proposed model

To assess the proposed model for estimating visits in open urban spaces, the results of the model for Pier of Saint Nicolas are compared with the selected data for another, more visited area of Patras Waterfront, the area of Marina. In specific, in Marina receives 27,900 visits per quarter of a year while the percentage of green areas is at 23.23%, the percentage of sidewalks/bike paths cover 40.5% of the urban space and the percentage of smart parking is at 0%. Based on the model, if the area of Pier of St. Nicola, which receives Y = 11,700 visits in three months, reach the percentages of Marina regarding the three parameters of the model, the visits will be multiplied by 2.24. This means that the study ares will receive 26,260 visits/a year quarter. The estimated number of visits is very close to the observed one in Marina and the deviation of the prediction is at 0.058% which is indicative of the usefulness, transferability and accuracy of the model.

## 5. EVALUATION INDEX: "VISITING OF OPEN URBAN SPACES"

The decision-making process dealing with the regeneration of an urban space and the interventions that can be made in it, should take as a serious matter the wishes and preferences of the users. Open urban spaces are addressed to citizens and their success lies citizens 'acceptance. The proposed model for estimating visits in an urban area alone is not enough to provide the information that managers need to make decisions even if it indicates users' priorities. The number of citizens' visits to represents the Demand side for an urban space and it can be useful only when it is combined with the Supply side. The supply side can be represented by the size of public urban area that is offered to citizens. Therefore, the Visiting Index is the key indicator to be monitored and used by stakeholders in the decision-making process for urban regeneration plans and actions:

Visiting Index = 
$$\frac{\text{Visits in three months}}{\text{Area of Open Urban Space}}$$
 (3)

The Visiting Index is effective to be updated at most annually and at least every three years.

## 5.1 Land cost of urban space

The Demand side and the factors that determine how it changes have been previously described and they are represented through the proposed model. It is crucial to study how and on which basis the value of the Supply, ie the area of the open urban space, can change.

Therefore, as the demand for urban space increases, the offer of public space needs to expand too. To increase the size of an outdoor urban space, combined with the political decision, the financial cost that accompanies this decision is the main decisive factor. For this reason, an attempt is made to estimate the amount of money needed to add more open public space provided to citizens.

It turned out that for a medium-sized city (200,000-300,000 inhabitants) the value of land for municipal property amounts to 1500 €/m2 (Vihola & Kurvinen, 2016). Even if, in general, the area increases proportional to the money offered, there is a critical stage that the size of outdoor urban space cannot be increased in proportion to cost. In other words, a "dead zone" emerges, where the land cost changes. This point is estimated to be up to 2000m2. In this point, the public space is considered to act as a catalyst that leads to added value in the area, and consequently to an increase in the land value. In specific, an increase in the money offered per m2 is required to overcome the "dead zone".

The cost price increases by a factor of 27% and when it reaches 1900 €/m2 it is estimated that it will lead to the end of the dead zone and the addition of more outdoor space. The 6,000m2 is set as the upper limit, considering that the study focuses on medium size cities (Diagram 2). The cost and dead zone estimate is indicative as these prices may vary from region to region depending on its particular characteristics.

At last, it worth to refer to possible additional costs for the added space (Diagram 3). In specific, for areas that have been abandoned and initially hosted industrial uses, remediation and restoration actions are required, and the cost is estimated at 52€/m2 (De Sousa, 2002), the addition of greenery in the open space is estimated at 15€/m2 (Norwich City Council Local Plan, 2015) while municipal expenditures per year are considered up to 19€/m2 (Vihola & Kurvinen, 2016).



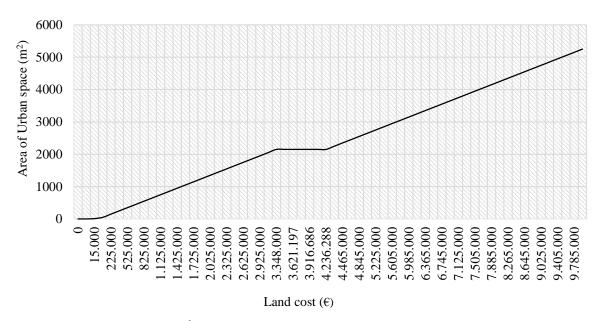


Diagram 2. Land cost to add urban space area

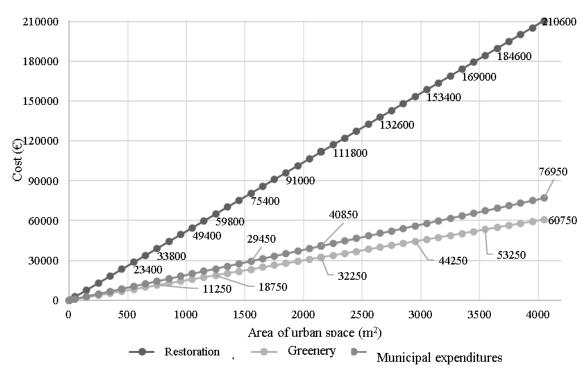


Diagram 3. Possible additional costs per sqm of urban space

## 5.2 Time constant of the Visiting Index

One other parameter that is of particular interest is the time required to change the value of the Visiting Index. Specifically, the cycle of changes that have been described presents some points of time delays as it includes processes that have many stakeholders and require time for both decision making and implementation. Specifically, an attempt is made to determine the time constant of the change in the citizen's visit on an outdoor

urban space. For this purpose, citizens were asked to determine the time period in which they will visit an outdoor urban area that meets the specifications they want and covers their needs. A percentage of 70% said that they would visit the site within 10 to 15 days after being informed about it.

Regarding the increase of the size area of the urban space they require years for the decision for regeneration and planning as well as for the implementation of the plans. Considering the design stage to be made through a competition (e.g., architectural), a period of 6 to 9 months is usually required from the moment of the announcement until the approval of the results. In addition, the time between the analysis of the current situation and the final implementation proposal (study and planning stages) has to added too. It is estimated from one to three years for medium intervention actions. Finally, the time of project implementation (time from the end of the design until the implementation of the approved plan) is usually from 3 up to 5 years or it can even reach a decade depending on the project (Georgarakis, 2017).

## 6. DYNAMIC RELATIONS OF THE VISITING INDEX FACTORS

A holistic approach describing the dynamic relationships among the factors of the Visiting Index is considered crucial and helpful for stakeholders to understand the impact of their decision in city. This connection either lead to a common increase of the correlated factors or the increasing tendency of one lead to the decrease of the other. Specifically, to describe these dynamic relationships, negative and positive loop transformations are used to create a causal loop diagram (CLD).

In the approach of public urban space as a dynamic system, the evaluation index "Visiting of open urban spaces" can be described as in the presented CLD (Diagram 4). In specific:

- As the number of visits that citizens make to a public open space increases, so does
  the Visiting Index: visits in 3 months / area of open urban space and vice versa.
  The above process is directly related to the number of citizens who are attracted
  by a public space and who wish to spend their time in it (demand) or vice versa.
- The increase of this index leads the decision makers to proceed with the provision
  of a larger area of public space (offer) for the citizens. The factor that significantly
  determines the growth of public urban space beyond demand and political
  decision is the financial cost that the implementation of these decision request.

In CLD all the positive or negative connections between the factors are indicated. The proposed CLD consists of negative loops, which are self-balancing cycles that tend to seek and maintain a level. The approach of urban spaces as dynamic system and the study of these dynamic relationships enhance decision makers effort to achieve a satisfactory level of demand-supply relationship regarding open urban spaces leading to urban sustainability and resilience.

Among these dynamic relations, the connections studied in the research are simulated for the case study area (Pier of Saint Nicolas) in Vensim program to identify in which way the indicators change based on the different values of model parameters. The Base case shows the visits that the urban space will receive in a year considering the current situation in the case study area. Scenarios A, B, C, D simulate the estimated values of the Visiting Index if decision-makers change the model parameters (x1, x2, x3) in three



Scenario F

40

different ways/combinations while the size of the area remains the same. In these scenarios Visiting Index increases over Base in all cases and in specific, the increase gets bigger as the percentage of smart parking places (x3) is higher (Table 2, Diagram 5).

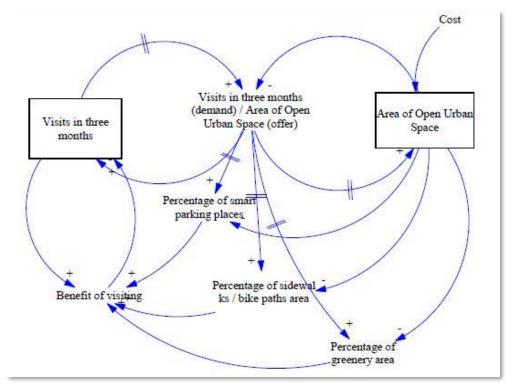


Diagram 4. Casual loop diagram of urban parameters dynamic relations

Table 1: Simulated scenarios and Visiting Index results

Visits in a year  $x_1(\%)$   $x_2(\%)$ X<sub>3</sub> (%) Area (people) (sqm) 0 23,700 97,322 4.10 Base 6 27

Visiting Index (people/sqm) Scenario A 5 35 54 23,700 113786 4.80 Scenario B 40 30 70 23,700 5.59 132,410 Scenario C 55 25 10 23,700 106,754 4.50 Scenario D 20 40 35 23,700 118,290 5.00 Scenario E 6 27 0 25,700 97,322 3,79

Finally, in Scenarios E and F the Supply side changes too. In specific, if more area is added to the open urban space while the factors of greenery, sidewalk/bike paths and parking remain the same, the Visiting Index will remain lower than the Base line (Scenario E). In Scenario F, the model parameters (x1, x2, x3) change as in Scenario B and the same time the size area increases too as in Scenario E. Diagram 5 reveals that in this option, Visiting Index gets closer to Scenario A, but it is still over Base Scenario.

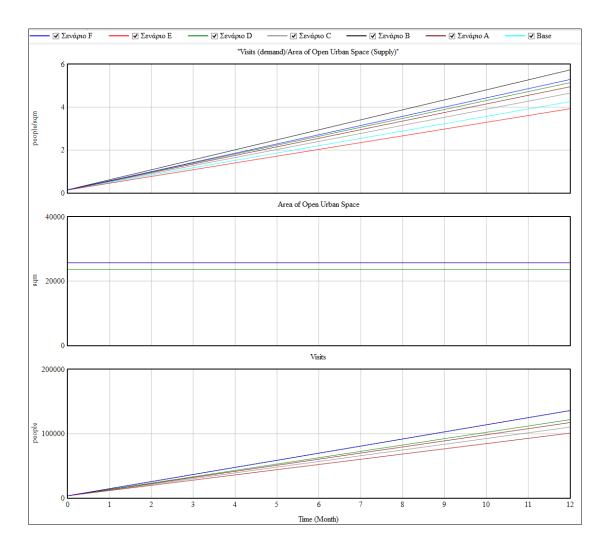
25,700

132,410

5,15

30

70



**Diagram 5.** Visits per year, Area of Urban Space and Visiting Index values over time based on the simulated Scenarios

## 7. CONCLUSIONS

The decision-making process on regeneration actions/plans of open urban spaces should be supported by monitoring and evaluating indicators in order to ensure city sustainability and resilience. In this process, citizens' needs and preferences should be in priority as urban spaces success depends on attracting visitors. The proposed model helps decision-makers to estimate the visits that an open urban space can receive based on three parameters rising as the main factors for citizens' selection. In addition, the Visiting Index is developed as a key performance indicator combining the demand on open spaces with the supply of them in urban systems. At last, the dynamic relations among the main elements of these are described in an effort to approach and understand the complex issue of planning and reforming urban spaces.

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