Methods of Identification and Evaluation of Brownfield Sites

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Abstract

The basic objective of this paper was to determine the importance and potential restoration of brownfield sites in terms of economic prosperity of a particular region or country. In addition, in a theoretical sense, this paper presents the methods used in the identification of brownfield sites such as Smart Growth Network model and Thomas GIS model, and methods for evaluation of brownfield sites or the indexing method, cost-benefit and multivariate analysis.

Keywords: Brownfield Site; Revitalization; Investments; Identification; Selection; Models.

JEL: M10, M12

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1. Introduction

Deindustrialization and suburbanization are two main reasons for the appearance of brownfield sites. The process of de-industrialization is accompanied by the decline of manufacturing and the expansion of the service sector. This process is particularly intensified in the late 1960s and early 1970s in Western Europe and Northern America. After that, the process of de-industrialization took place in Japan and in other Asian countries (Rowthorn and Ramaswamy, 1997).

With the process of de-industrialization, there was a closure of certain industries and job losses, as well as the abandoned land. The economic situation in local communities deteriorated. Abandoned land has lost its value and caused damage to the state and local community, in terms of tax revenues and other benefits missed. Parallel to this process there was the process of migration from abandoned brownfield sites. In fact, a process of suburbanization was

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ongoing. Deindustrialization and suburbanization resulted in abandonment of the different types of real estate. Remote community's sites are further affected by high unemployment, increased crime and a decline in GDP (Gibson, 2007).

Economies of Western countries, especially the cities have experienced major changes in the context of spatial restructuring, social and economic conditions. The process of globalization of industrial activities has led to the closure of certain businesses, or complete loss of entire manufacturing industry and industrial centers. Strong growth in the service sector and change in the way of urban life has also led to significant changes in land use. These processes have resulted in the creation of brownfield sites in urban areas. Brownfield sites are primarily the result of deindustrialization that led to the neglect of certain areas and the loss of importance of certain towns (Tolle, 2009). Brownfield issues are gaining importance in developed countries during the 1970s. In the foreground are imposed problems of sustainable urban and regional development. Sustainable development as a theoretical concept is gaining importance in recent decades. Possession of sufficient arable land and resources are considered as key factors for the progress of human civilization. However, the sustainability of land resources is a source of sustainable development. Brownfield sites are land or property that is not currently being used in an optimal way. Mayers and Wyatt defines brownfield sites as places that are not currently used or as non-agricultural land resources (Myers and Wyatt, 2004). Brownfield refers not only to re-strengthening city quarters, but also the efficient use of non-agricultural land located in the outskirts of the city. Efficient, cost-effective and sustainable land use directly affects the strengthening of national competitiveness.

In early 1980s, Western European countries faced with a sharp fall in output in the mining, steel and textile industries, which led to the undertaking of structural reforms in the traditional regions. Within the European structural policy was conducted extensive brownfield revitalization strategy, particularly it relates to the British area of Lorraine, France area Nord-Pas de Calais and the German area of Northrhine-Westphalia. However, after the 1990s, philosophy towards brownfield sites is changing in terms of quality and quantity (urban and housing brownfield), and actually it begins with integration of the countries of Eastern Europe. Accordingly, as of 1980 at the European level, the European Regional Development Fund (European Regional Development Fund - ERDF) is used as the main financial instrument for the revitalization of abandoned industrial areas. In addition, social initiatives for certain specific sectors have been developed, such as "RESIDER" in places where there are steel mills, "RECHAR" for mining sites, "RENAVAL" for shipyards "RETEX" for the textile industry sites. All the above programs are aimed to assist in the implementation of structural reforms in traditional industrial areas of Western Europe. In the last two decades within the EU is growing interest in the recording of environmentally contaminated soil or location. So by adopting the ESPD (European Spatial Development Perspectives) in 1999, as a formal tool in spatial planning, EU set specific goals and principles of urban renewal of locations, or sites, which implicitly represents the interest of the EU in the field of brownfield. After that, the EU has adopted the Territorial Agenda 2007 document which confirms previously defined guidelines (Tolle, 2009).

2007 has been a turning point in relation to brownfield, and member states were encouraged by the Community Strategic Guidelines on Cohesion and start-up programs in urban areas, ie. promotion of internal cohesion within

urban areas by improving the conditions of disadvantaged neighbourhoods, especially the physical environment and the preservation and development of their historical and cultural heritage (Ferber, 2011). On the agenda of EUBRA 2007, the restructuring of brownfield sites has gained in importance in the context of European development policy. In addition, the Lisbon Treaty and the EU Sustainable Development Strategy defined the specific goals of economic growth, job creation and environmental awareness. Sustainable urban redevelopment and revitalization is an essential component in the promotion of economic development, employment growth, social inclusion support and protection of the environment. Bearing in mind that today in EU more than 60% of the population lives in urban areas and therefore cities are required to have an important role in this process (Tolle, 2009).

The first generation of brownfield sites in Europe emerged in the 1980s with the closure of the mines, steel mills and textile companies. Subsequently, in the 1990s the military assets were reduced and certain transportation infrastructure was abandoned, thus these sites are added to brownfield sites. During and after this period the cycle of sites restructuring and their redevelopment was initiated. The above process is not only affecting the EU, but also Eastern European countries or countries in transition. After the fall of the Iron Curtain many countries of Central and Southeast Europe faced a strong decline of industries. Industries have become redundant because they could not be competitive in terms of production. As a result, their markets were declining and companies were privatized in several phases. Privatization has not been successful in the majority of cases, leading to deterioration of property of even stronger companies. In fact, the main objective of privatization was not the creation of new functional and creative companies, but the owning of their property. Usually at the end the property was in very poor condition and often has been the subject of sale and the rental for the production of certain products that have a negative impact on environmental pollution. Of course, along with physical deterioration of given locations and the degradation of their ownership status and integrity occurred. Problems of privatization, involving owners and trustees, led to poor options on assets to be sold for redevelopment. Additionally, these sites did not have a clearly defined ownership status and were often the subject of mortgages, which resulted to be overvalued in relation to their actual value.

2. The Theoretical Framework and the Definition of Brownfield Sites

Based on a study Cabernet (Concerted Action on brownfield and Economic Regeneration) in the EU there is no universally accepted definition of brownfield. Accordingly, in most European countries brownfield mainly refers to areas or sites that are faced with the problem of pollution. A literal translation of brownfield is brown areas or brown fields. There are many definitions of brownfield sites and these are mainly European and American perceptions. In the European context there are a number of definitions and interpretations, with the most common one suggested by the working group CLARINET (Contaminated Land Rehabilitation Network for Environmental Technologies), which states: "the brownfield are sites that had previously been under the influence of their users and the surrounding areas, which are neglected or underutilized, which may have potential problems with lack of maintenance, which are located mainly in developed urban areas and require intervention to bring them back to beneficial use "(Cabernet Sauvignon, 2010, Miljuš and Vujošević, 2012). Understanding what is and what is not brownfield depends on local circumstances. According to a certain standard conception, the brownfield is considered as buying and putting into operation a

company or location by another party. In addition, it is understood that certain brownfield may be partially used. According to the general view, brownfield sites are for a long time out of use, and the standard description of "underutilized" means that these places will be in use again. For example, certain companies carried streamlining or reducing the number of employees. Therefore, the area or part of a place that is no longer used by the owner is considered to be brownfield, even if other parts continued to be productively used. Since there is no universally accepted definition of brownfield, then this is another obstacle in their revitalization (Brownfields Handbook, 2006).

According to Alker-in et al., brownfield term is defined from a multidisciplinary perspective, in fact brownfield sites are "land or space that was previously used and is not fully operational, though partly can be used. Or, it may be abandoned, derelict and contaminated area "(Alker, et al., 2000). According to Dixon and Adams, "brownfield sites pose any land that was previously developed, including derelict and vacant land that may or may not be contaminated" (Dixton and Adams, 2008).

Below we give a few definitions of brownfield that are officially used in EU countries. In Belgium, brownfield sites are places where previously there was an economic activity, which current state of affairs is contrary to the efficient use of land (Sites activite d'Economie desaffectes - SAED). In France, the brownfields are sites that have been developed, but due to the cessation of activities have been temporarily or permanently abandoned, and should be set for future use. Locations can be partially occupied, abandoned or contaminated (Ministere de lenvironnement). In Germany, the brownfields are buildings in the inner city that are not in use. The inner parts of the city are to be rebuilt and restored (Unweltbundesmt Berlin). In the Czech Republic brownfield sites have been changed by previous use of the site and the surrounding land, which are abandoned or underutilized; may have real or perceived contamination problems; are mainly in developed urban areas, and in need of interventions that could be reused (CABERNTE definition CLARINET - Contaminated Land Rehabilitation Network for Environmental Technologies). In Denmark, the brownfield site is contaminated land. In Bulgaria brownfield sites are contaminated areas in which previous activities have ceased, but which still affect the neighbouring areas and so on. (Oliver, et al., 2005). In the U.S. brownfield is defined as a location that is equivalent to the property that is affected or potentially contaminated.

Alker et al., have identified several key elements of the definition of brownfield locations or sites: contaminated, abandoned land, previously used land and request for intervention (Yu-Ting, 2011). Contaminated land: brownfield or contaminated lands are generally defined as synonyms. It is well known an international example of USEPA definition: real estate, expansion, rehabilitation or reuse which may be complicated due to the presence of dangerous stuff, harmful substances or contaminants. Examples of definitions brought by CABERNET in this category are the definitions of Belgium, Denmark, Poland, Romania and Bulgaria. Abandoned land: brownfield site is mostly a synonym for neglected and unused land, and that may not always be contaminated. Examples of definitions that states CABERNET within this category are definitions of Ireland and Slovenia. Previously used land: brownfield site is defined as land that has been previously used. This creates a broad definition that could include urban areas, such as gardens and school playgrounds that are derelict or contaminated. Examples of the definitions included by CABERNET in this category are definitions of United Kingdom, Germany and Belgium. Request for intervention: to

bring brownfield location back to its original state it is necessary that the place has unfavourable characteristics, that is neither abandoned nor contaminated. This makes it problematic for reuse. Definition of CLARINET and CABENET lists definitions that fall into this category, and these are definitions of France, Austria, the Czech Republic and Latvia.

Brownfield sites are areas and facilities in urban areas that have lost their original intended use or they are underused. It is believed that these locations are ecologically polluted and there are ruined products and other objects in those locations. Brownfield sites are most of the urban areas in many cities. Given that they negatively affect their wider environment, not only in economic, but also aesthetic, psychological and social terms. Their complexity is associated with increased risks, costs of their reconstruction and re-use, which discourages foreign direct investment. In addition, brownfield sites require the intervention of the wider community to remove barriers to their development and initiate the process of their new ways of using (Manual for decision-making and professional, 2008). Brownfield sites cause the increased environmental contamination, increase in unemployment, a decline in economic activity, deterioration of neighbourhoods. The renovation of these sites is risky and reluctantly accepted among the local population, as it leads to high costs of repairs, low rates of return on investments, the disappearance of old buildings in the region (World Bank, 2010). Despite this, the revitalization of brownfield sites is considered as a way to improve the sustainability of a country or region.

Brownfield sites include several values (see Figure 1). These values represent the cultural identity of brownfield sites. The historical value of the site is written through the activities that took place at that location. Through their revitalization memories of them again evoke. Through their existence these sites inform citizens about their position in the past. The social value of brownfield sites is reflected in the information about the lives of ordinary people in the past and present. Their reconstruction improves the quality of life within the community. The psychological value of brownfield sites is reflected in the creation of a sense in the community that the property belongs to the city or region. Recognizing that the quality of life is improving, the citizens get the feeling that the government cares about them. Technological value of brownfield sites is reflected in the data that speak of the progress of science and technology. Their reconstruction in terms of technology is important because it reminds us of the technological past of the future generations. The ecological value of brownfield sites is related to the restoration of the local landscape. Through restoration these sites become centers of habitats and ecological life. The spatial value of brownfield sites are characterized by their artifacts and topography. The ecological value of brownfield sites is reflected in the importance of open space in the city. With their reconstruction environment becomes cleaner and stronger in terms of green infrastructure. The economic value of brownfield sites is reflected in the availability of land for investment. The renovation of these sites achieved a positive economic impact on the environment. Increasing property values and employment opportunities are just some of the impact of relevant investment (Baskaya, 2010).

Figure 1. Value of brownfield sites

Source: Baskaya, 2010, p.76.

3. Overview of Brownfield in EU

In the U.S. and Europe during the 1980s, governments have adopted specific standards for the revitalization of brownfield sites. The U.S. government had a goal to clean up contaminated brownfield sites at the national level, adopting CERCLA document (Comprehensive Environmental Response, Compensation and Liability Act - CERCLA) that protect innocent owners or users, and ensures that the contaminated area is cleaned and that the cause is responsible for the cost of remediation. In addition to this document, legislative act or RCRA Resource Conservation and Recovery was adopted. During the 1990s, the U.S. government has invested over 1 billion dollars to more than 120 brownfield sites (Fangfang, 2007). It is estimated that in the U.S. there are over 1 million brownfield sites (Wernstedt, K., et al., 2004). In EU countries, many brownfield sites are contaminated and returning them to the former condition requires considerable effort. The European Agency for the Environment (The European Environmental Agency - EEA) assessed that there are over 1 million contaminated sites. Over 70% from the specified number are brownfield sites which are used for military or industrial purposes (Special Report, 2012). Due to the lack of built databases, as well as differences in definitions of brownfield sites, it is difficult to make a comparative analysis of the data, as well as the extent and nature of brownfield land in the EU. In the case of those countries where data on total area of brownfield land are available, we can say, based on reports CABERNET Network Report, that the Netherlands has over 11,000 ha, Germany 128,000, Poland 800,000 ha and Romania 900,000 ha of land.

Figure 2. Population and Competitiveness of Selected European countries

Source: Oliver, L. (2005), et al., p.1.

Brownfield density stands for brownfield land as a percentage of the total area of a particular country. Brown field density is between 0.25% and 0.5%. The percentage of land within these margins is a brownfield land. For example, Sweden and France have low brownfield density or less than 0.05%, while Poland 2.5 and Romania 3.8% have high density. In addition to this problem there is a difference in the reported number of brownfield sites and the size, which leads to differences among the analyzed countries. For example, there is data that France has 222,000 brownfield sites, which amounts to 20,000 ha of land, or an average of 0.09 ha per location. In the case of Poland, the average is 248 ha per location. This large difference can be explained by the industrial history and the existence of various definitions of brownfield between countries. Oliver, et al., have investigated the relationship between competition and population density of European countries with the aim of categorizing countries according to the brownfield problem (Nicole Report, 2011).

Three categories of countries have been identified: 1) the Scandinavian countries and Ireland are characterized by high competition and low rates of population density. Brownfield investments are aimed at tackling the contamination or pollution, 2) Western Europe (UK, Germany, Belgium and the Netherlands): these country have high population density and lack of greenfield land, and therefore perform redevelopment of brownfield sites, 3) the countries with medium population density (Denmark, Austria, France and Spain) are less competitive and achieve great benefits of reuse of brownfield sites (Nicole Report, 2011).

When we speak of brownfield sites it is important to emphasize the importance of investment in the process of their rehabilitation and reuse. Reduction of investment in brownfield sites occurred mainly in developed countries. The main reason for this, in addition to financial and credit constraints, is a high risk for this type of investment, and weak prospects for economic growth in the world. During the period from 2007 to 2009 the decline occurred in brownfield investments and withdrawals of capital occurred as well. Brownfield investments within the EU have decreased by 67% in the EU compared to 2007 (Warzau, 2013). However, based on Table 1 we can see that the value of brownfield FDI increased in the 2011 compared to 2010 year, or an average annual growth rate in the period from 2006 to 2011 in the EU was growing by 32.6%. Observed by countries, the highest rate of growth was in Poland, Liechtenstein, Czech Republic and Belgium. On the other hand, the biggest decline or negative growth was recorded in Estonia, Slovakia, Malta etc.

Table 1. Value of Brownfield Foreign Direct Investment by Countries (in billions dollars)

<i>Country</i>	2006	2007	2008	2009	2010	2011	Average annual growth rate 06-11 (previous year=)	Grow rate in 2011 2007=100
EU Total	333337	527718	251169	116226	115974	172257	500,5	32,6
Austria	1145	9661	1327	1797	432	6928	2620,7	71,7
Belgium	1794	961	2491	12089	9444	3920	917,7	407,9
Bulgaria	807	971	227	151	24	-96	-173,9	-9,9
Cyprus	294	1343	-909	52	680	780	1805,8	58,1
Czech R.	1154	107	5169	2669	-457	725	4716,0	677,6
Denmark	11235	5761	6095	1651	1448	7659	800,8	132,9
Estonia	3	-57	110	28	3	239	5909,9	-419,3
Finland	1321	8313	1153	508	324	973	1051,3	11,7
France	19423	28207	4590	724	3837	24325	1341,2	86,2
Germany	41388	44091	31911	12790	8507	12709	432,9	28,8
Greece	7309	723	6903	477	-899	1205	652,7	166,7
Hungary	2337	721	1559	1853	213	1714	1182,1	237,7
Ireland	2731	811	2892	1712	2127	2181	672,3	268,9
Italy	25760	23630	-2377	1109	6329	13450	818,2	56,9
Latvia	11	47	195	109	72	2	966,9	4,3
Lithuania	97	35	98	20	462	386	2730,0	1102,9
Luxembourg	35005	7339	-3570	444	5446	9393	1358,9	128,0
Malta	517	-86	0	13	315	0	2391,3	0,0
Netherlands	25560	162770	-8156	17988	4113	14031	775,3	8,6
Poland	773	728	966	776	1063	10043	1389,0	1379,5
Portugal	537	1715	-1279	504	2208	911	684,7	52,1
Romania	5324	1926	993	314	148	88	225,9	4,6
Slovakia	194	50	136	13	0	0	307,3	0,0
Spain	7951	51686	33708	32173	8669	17298	1037,2	89,0
Sweden	15228	4563	18770	1098	221	7616	3913,4	33,5
UK	125421	171646	147748	25164	60833	35691	540,4	20,8

Source: Warzala, R. (2013), p.176.

In addition, the following Table 2 presents the implementation of structural measures in the process of revitalization of industrial and military sites in the EU. In total EU countries have invested in 2007-2013 period over 3,390 million euros, an increase of 1,142 million euros compared to the period 2000-2006 period. Among the countries that lead in structural measures taken to revitalize brownfield sites, or that have achieved growth is Hungary with 14%, Czech Republic 11%, Germany 9.9%, Italy 8.8% and Poland 8.2%, etc.

Table 2. Structural Measures Funding the Revitalization of Industrial and Military Sites (2006-06 and 2007-13)

2000-06 Structural Measures regeneration of industrial and military sites				2007-13 Structural Measures regeneration of industrial and military sites			
Member state	Rank	Amount allocated (euro)	%	Member state	Rank	Amount allocated (euro)	%
Germany	1	645 490 864	28,7	Hungary	1	475 191 832	14,0
UK	2	574 288 905	25,5	Czech R.	2	372 290 509	11,0
France	3	195 305 373	8,7	Germany	3	335 518 228	9,9
Netherlands	4	160 821 924	7,2	Romania	4	316 430 710	9,3
Portugal	5	156 012 924	6,9	Italy	5	298 355 961	8,8
Italy	6	143 383 095	6,4	Poland	6	278 413 953	8,2
Belgium	7	65 421 025	2,9	Portugal	7	191 960 262	5,7
Greece	8	55 655 389	2,5	UK	8	178 957 047	5,3
Spain	9	54 873 962	2,4	Spain	9	177 403 701	5,2
Czech R.	10	46 073 161	2,0	Estonia	10	138 045 325	4,1
Poland	11	43 940 360	2,0	Slovenia	11	130 400 000	3,8
Hungary	12	28 773 946	1,3	Bulgaria	12	108 322 014	3,2
Finland	13	18 104 950	0,8	France	13	90 193 437	2,7
EU interregional	14	17 035 874	0,8	Belgium	14	62 048 204	1,8
EU cross-border	15	13 996 478	0,6	Latvia	15	49 000 000	1,4
Latvia	16	11 414 454	0,5	Malta	16	48 280 000	1,4
Luxembourg	17	10 019 687	0,4	EU cross-border	17	47 801 926	1,4
Slovenia	18	2 924 609	0,1	Netherlands	18	28 799 000	0,8
Malta	19	2 539 367	0,1	Greece	19	26 295 000	0,8
Estonia	20	1 712 389	0,1	Cyprus	20	16 150 000	0,5
Austria	21	674 726	0,0	Lithuania	21	14 501 892	0,4
				Luxembourg	22	3 786 550	0,1
				Finland	23	2 071 886	0,1

Source: Special Report, 2012., p. 44.

The European Union through the European Regional Development Fund (ERDF) in 2014 – 2020 period will invest 336 billion euros for the development of regions within the EU that are facing brownfield issues. Revitalization of brownfield sites that had been previously used as a military facility, mines and industrial areas fall under the umbrella of policy of green and innovative economic development^b.

4. Categorization of brownfield sites

Brownfield forms of property and their categorization can be designed and analyzed in several ways. The table 3 shows the classification of brownfield property on the basis of previous modes of use.

Table 3. Brownfield forms on the basis of prior use

<ul style="list-style-type: none"> - Industry - Military - Railway and transport - Agricultural - Institutional (schools, hospitals, prisons) - Commercial (shopping centres, offices) - Cultural (culture, houses, cinemas) - Leisure (sports grounds, parks, open space)
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^b <http://www.euractiv.com/specialreport-industrial-revival/green-eu-budget-pump-money-brown-news-514007>

In most countries of Central and Southeast Europe, there are several categories of brownfield sites that have previously had a specific purpose. Brownfield sites include military facilities that had once military use. Furthermore, there are certain locations such as abandoned railways, whose facilities are often located in the center of settlements. In addition, we have brownfield sites in the form of unused public facilities and abandoned hospital complex, correctional centers, schools, community centers, etc. In smaller municipalities there are abandoned agricultural cooperatives and agribusinesses, etc.

The above Brownfield classification is not the best because it does not take into account the benefits of certain brownfield sites. This means that certain objects of social significance that have not had an economic function, but are located in the central-city area may have higher economic potential than abandoned production facilities in the industrial zone, which does not possess adequate municipal infrastructure and are environmentally contaminated (Ferber, 2010).

According to the Switzerland Brownfield classification could be distinguished: 1) sites in central urban areas, where the value of revitalized land after preparation and transformation is very high, which makes them attractive enough for private investors without the intervention of the state, 2) brownfield in the peripheral areas of cities are characterized by lower value of the land, so contribution of public sector is necessary in order to attract potential investors, and 3) locations in rural and urban areas, where the value of recycled land is negative, which requires substantial financial support from the state, through direct subsidies and tax exemptions (SCTM, 2011).

Ferber and Grimski identify three categories of brownfield sites (Ferber and Grimski, 2001):

- i. *Brownfield in traditional industrial areas – as a result of a massive decline in employment in the mining, steel and textile industry in the early 1980s;*
- ii. *Brownfield in urban areas – as a result result of permanent migration in the peripheral areas during the expansion process of urbanization, and*
- iii. *Brownfield u rural areas – as a result of abandonment of sites related to primary economic activities in agriculture, forestry, mining, etc.*

It was more discussed on brownfield sites in traditional industrial and urban areas in the introduction to this work. Rural places have different problems related to the environment in relation to urban areas. For example, rural communities are naturally related to natural resources, such as forests, raw materials and natural spring water. Accordingly, solving environmental problems related to brownfield sites in rural areas is much more sensitive than in urban areas.

Greater population density in urban areas, especially in larger urban areas, affects the increasing demand and competition for brownfield sites due to the existence of certain infrastructure facilities. In the rural areas, there is usually less demand for the land and there is enough Greenfield land available. This is resulting in lower demand for brownfield conversions. It is often the case that rural places are quite isolated with inadequate infrastructure compared to urban areas. Therefore, the option of reusing brownfield sites is limited in rural areas. Rural places are facing difficulties in providing economic incentives for participation of private sector in the rehabilitation of brownfield sites. This means that in these places there is a smaller tax base, which means less possibility of tax exemptions on the basis of revitalization. These places are not able to expand their poor infrastructure that is necessary for the further development of Brownfield. In addition, these sites have limited personnel resources and technical solutions in relation to large urban areas, etc. However, rural places in most cases can respond faster in case of brownfield problems solving than in urban places because of the less complicated bureaucracy.

5. Methods for the identification of brownfield sites

Identification of brownfield sites is done in a way that potential sites are compared with pre-defined characteristics of brownfield. But here the problem arises because not all brownfield sites are registered. There is a rational explanation for that. According to Coffin and Mayers, a major problem in collecting information is a potential fear of the negative impact on the value of the property, a concern that flawed data will be used to describe the site as brownfield site, concerns about the limited institutional capacity to develop such a register and the inability of the community to recognize purpose of such a register (Coffin and Meyer, 2002). All these create difficulties in the evaluation of brownfield sites. Due to limited financial resources and the existence of a

large number of potential brownfield sites, the selection of potential sites becomes problematic. In order to make the right decision it is necessary to use relevant information and methods in order to integrate information. Thus, two evaluation methods are known to us, these are Smart Growth Network model from 1996, which was developed in the case of three American cities, with purpose of developing an integrated approach to the assessment of potential brownfield sites, and Thomas model from 2002, which ranks brownfield sites on a priority basis.

In 1996 several non-profit and government organizations joined U.S. Environmental Protection Agency in order to form a Smart Growth Network - SGN. The network was created in response to the growing social concern about the need for new ways of economic growth, environmental protection and the community vitality improvement. Partners in the network are groups for the protection of the environment, history conservation organizations, professional organizations, programmers, local and state authorities, etc.. Model Smart Growth Network SGN is used in selecting potential brownfield sites in terms of their economic feasibility, social and environmental benefits. In the model, the emphasis is on economic and social criteria, while environmental ones are ignored. In principle, the framework includes six steps to identify brownfield sites: targeting geographical areas, identification of brownfield sites in each area, a division of brownfield sites on a competitive basis, identification of high potential for the local community, estimation of the potential impact of alternative conversion, ensuring information to individuals and organizations involved in setting priorities and developing strategies for brownfield revitalization (Fangfang, 2007). The concept of Smart Growth Network underlines the importance of efficient use of land, and is also used in brownfield conversion. In addition, this concept deals with the improvement of transport patterns in terms of increasing the availability and options. Finally, this model emphasizes the availability or the ability of people to reach desired goods, services, and activities (Djokic and Sumpor, 2010). On the other hand, Thomas GIS model integrates geographic - spatial and socio - economic data. This model enables the stakeholders and the public to quickly and easily access the web site as well as to participate in the planning process. Thomas model selects brownfield sites based on the ranking criteria. This model uses 12 based on which, an assessment of the specific location is being made. Primarily there are seven criteria, which are related to the local ranking of the local and five criteria for county-region ranking (see Table 4 and 5). Based on this assessment, the local authority considers that physical factors are important, while the regional government believes that market factors are important.

Table 4. Weighting and Ranking Criteria for Brownfield Site Selection at The Local Level

Local government ranking criteria	Max. point value (weight)
Site Conditions	30
Compatibility with Local Land Use Controls (Zoning Ordinance)	25
Current Use Compatibility with Local Land Use Plans (Master Plan)	20
Compatibility with Surrounding Land Uses	15
Utility Infrastructure Capacity	10
Telecommunications Infrastructure	10
Transportation Infrastructure	10
Total available points (local)	120

Source: Thomas, M. (2002a), pp.7-23.

Table 5. Brownfield Site Selection, Weighting and Ranking Criteria at The Country Level

County authority ranking criteria	Max. point value (weight)
Financial Incentives	40
Environmental Risk and Compliance	30
Land Re-Use Preferences	20
Labour Resources	10
Market Conditions	10
Total available points (regional)	120

Source: Thomas, M. (2002a), pp.7-23.

Methods on the basis of which is possible to evaluate different sites in the wider area and bring the best solution were developed in order to provide a more adequate way of remediation of certain brownfield sites. In this regard indexing method, cost-benefit analysis and multivariate analysis are proposed. The *indexing method* scans large areas and sites that are taken into account when making decisions about their conversion and revitalization.

Subjects were rated on the basis of three indicators, each containing the appropriate indicators. *Socio-economic index* include: population density, the value of real estate and unemployment. Combining elements of the socio-economic index, we can identify potential brownfield sites that will contribute to economic growth. *Spatial index of growth* indicates the vitality of an area, and includes indicators such as the availability of utilities and transport, employment opportunities and housing. *Environmental index* includes indicators of the source of potential contamination, soil permeability, proximity to water sources and parks, the presence of wetlands and floodplains. All of the above indices are combined when the decision is to be made on the selection of suitable brownfield sites.

In the process of combining three indicators indexes or multivariate analysis, there is a possibility of different rating of indicators depending on the importance of a particular context. For example, if the indicator on the employment rate is assessed as the most important for a particular area, then it gives greater importance to social index of growth, or if the sources of contamination are considered important, then the environmental index gains increasing importance. In addition to this it is important to emphasize that it is not advisable to combine the three indices in one when their nature and spatial dimension are incompatible. For instance, socio - economic and spatial indexes can be applied at the regional level, while the environment index can be applied to each brownfield site. Within the multivariate analysis, decisions must be discrete, possible alternatives must be measurable; data must be quantitative and qualitative in nature (Jankowski, 1989). In the end we can say that this method has no intention to assess the relevance and redevelopment of certain sites, but to serve as a preliminary method when there are a large number of potential sites (Chrysocoou, et al., 2012).

At the end the third *method of cost-benefit analysis* is used in order to identify all potential costs and benefits of brownfield sites. In this method, there is a problem of quantifying or measuring the effects because it is about the benefits and costs that are difficult to measure. We divided this analysis into two parts. Firstly, we will try to explain the costs, and then the benefits. The costs of brownfield revitalization include primarily common costs for remediation of certain locations (e.g. costs for redevelopment, and the costs related to the assessment of pollution, planned costs and direct costs of remediation). Brownfield recultivation costs are associated with a final purpose of the location. For example, the use of land for recreational purposes requires a different level of purity in relation to industrial land use. Another characteristic of the cost of recultivation is that they are difficult to predict, as well as their actual state. The status of the contaminated areas is difficult to detect during the cleaning process. In addition to these costs, brownfield revitalization includes typical financing costs due to the higher perceived risk associated with the project. One special feature of brownfield is that they are often located in developed urban areas. In relation to Greenfield investments, brownfield investments in the reconstruction, cause significant environmental externalities over a long period of time (Groenedijk, 2006).

When we talk about the benefits, then we distinguish the following: economic, social and financial benefits for private investors, as well as fiscal benefits for the government. Economic and social benefits of brownfield revitalization are numerous and include:

- *protection of public health and safety, including protection of groundwater and soil*
- *reducing development pressure on greenfield sites (reducing city sprawl),*
- *reduction of externalities of transport (air pollution) in suburban traffic,*
- *retention of existing jobs and creating new,*
- *reconstruction of the city center, the removal of socio-economic stigma that is associated with the living at brownfield sites, access to affordable housing, etc.*

The main motivating factor for involvement of private stakeholders in brownfield revitalization is the actual profit gained from the development of site, or its direct exploitation or sale of the property after revitalization. The main commercial benefits are cash flow from economic structures (e.g. residential buildings, offices, recreational facilities) on revitalized sites, income from the sale of refurbished property. Fiscal benefits for the government relating to the renewal and strengthening of the tax base for free and underused sites (e.g. increase in revenues from sales taxes on property, income taxes), increasing the utilization of existing heavy infrastructure

and public services (e.g., revenues are increasing from better dispersion of fixed costs, revenues are increasing from use fees, income from development fees) (Groenedijk, 2006).

6. Conclusion

Based on our analysis, we found that the brownfield issues become especially important in the EU countries and transition economies after a period of de-industrialization and subregionalism. The presence of a significant percentage of brownfield sites pose to the local region or state a potential problem, as well as the possibility of development. A large number of countries are faced with a lack of greenfield sites, and they see the revitalization of derelict brownfield sites as an opportunity to reach additional land for potential investors. Thus, in this work we found that, in particular, certain countries within the EU are the leaders in the process of revitalization of brownfield sites and attracting foreign investors. In this regard, the EU is investing significant funds in order to reduce the number of brownfield sites that are a potential source of re-growth, or risk of possible economic and demographic extinction.

In this paper, we found that when applying the identification model of certain brownfield sites a problem arises in the site selection process involving a lot of factors, so there is a possibility of incorrect assessments of specific sites, or disparagement of their true value, and putting them on the back burner. Therefore, we determined that there are only two models that offer the optimum choice of brownfield sites. Smart Growth Network model is used to select potential brownfield sites in terms of their economic feasibility, social and environmental benefits. In this model, the emphasis is on economic and social criteria, while environmental are ignored. On the other hand, Thomson GIS model integrates geographic - spatial and socio - economic data. In this model the selection of brownfield sites is done based on the ranking of certain criteria at the local and state level as well. In addition, in this paper we explored the application of methods for evaluation of brownfield sites. In the first place, we found that there are only three methods, namely: the indexing method, cost-benefit analysis and multivariate analysis. Each of these methods has its advantages and disadvantages. Therefore, it is very important to note that these methods for evaluation of brownfield sites measure certain elements of the site, and it is necessary to know that these are not universal methods. This means that each of the above methods can be used only for the particular form of brownfield sites. Finally, in our analysis of the brownfield issue, we came to the conclusion that the methods used in the identification and comparison are effective tools for making optimal decisions on restoration of brownfield sites.

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