URBAN PLANNING IN CRACOW AND LOCATION OF SUSTAINABLE OFFICE BUILDINGS

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Abstract

Social, economic, and environmental benefits of sustainable buildings result in increasing demand and supply of green office space and governments adopt green buildings requirements as policy instruments. Effect of public (local, state) policies on construction and diffusion of sustainable buildings have been analyzed in few research (e.g. (Choi 2010a), (R. Simons, Choi, and Simons 2009)), demand for sustainable offices (e.g. (Zieba, Belniak, and Gluszak 2013), motivations for investing (Fuerst and McAllister 2009)(Popescu et al. 2012) were the subject of research but the impact of public policies and tools used by local governments, in the form of development plans and zoning maps, on the location decisions of investors realizing green buildings still requires more insight.

The objective of this paper is to verify whether local development plans (zoning maps) facilitate location of sustainable office buildings on sites that are best-choice using the criteria of green buildings' certification and most beneficial from the point of view of sustainable urban development.

Authors assume that local governments would support choice of best sustainable location by investors, as it's beneficial for local community, economy and environment. Also, we state that real estate developers' choice of location is the function of firm's own criteria, zoning map

restrictions, availability of land for new developments.
This paper proposes a methodology to identify the best areas to locate sustainable offices in Cracow district Zabłocie, using spatial data analysis.
Zablocie was selected because the zoning map exists for the whole district and the area - postindustrial district, still provides many sites for new developments and it's featured by high concentration of sustainable office buildings.
The evaluation criteria was based on BREEAM (BRE Environmental Assessment Method) green building certification categories. The data was collected and processed in ArcGIS. The locations, identified in spatial analysis process, were compared with locations available in Zablocie for commercial (office) developments as indicated by local development plan.

Sustainability in property investments

Real estate market and construction sector together have significant impact on natural environment and also strongly influence social and economic situation on the local, regional, countrywide and global level (Belniak, Głuszak, & Zięba, 2013, pp. 61-69). Buildings consume large amount of energy, potable water, construction materials, generate immense amount of greenhouse gas emissions, are resource intensive are generate considerable amounts of waste. These features make them perfect vehicles to achieve energy efficiency, carbon abatement and corporate social responsibility (Chegut, Eichholtz, and Kok 2013). The goals could be accomplished with construction of sustainable buildings (or green, high-performance), which are the response of construction and real estate industry to environmental concerns, are featured by reduced negative environmental impacts, solutions aimed at improving local social, economic and ecological conditions, and by lower energy and water consumption, economic use of unrenewable resources, lower 'production' of waste, health and wellbeing of users' concerns. Design and technological features of sustainable buildings include several parameters aimed at achieving ecological and social goals (Shiers 2000) and *"are designed, constructed and operated to boost environmental, economic health and productivity performance over that of conventional building"* (Shi et al. 2014) . Construction and investing in sustainable properties is the most direct way of applying Responsible Investment concept into real estate market. RI combines in business decisions environmental (reduction of negative environmental impacts, protection of natural environment), social (wellbeing and health, security of employees, and local community), economic (profits, value, cash flows) criteria (Pivo 2008) (Portney 2008) (Garriga and Melé 2004) (Revelli and Viviani 2015) (Rapson et al. 2007) (Pivo and Mcnamara 2005). This invesmtnet conpcet endorses ivestors and shareholders goals and acknowledges and encourages fullfillment of duties for the society and natural environment.
The paper does not focus on the concept and policies of sustainable urban development, but introduction of the concept demonstrates that promotion of green buildings converges with it, and supports green urban growth, socially and environmentally friendly, while economically sustainable.
Sustainable urban development concept of urban of development, recently applied by policy-makers, encompasses four major aspects of sustainable urban communities: institutional, social, environmental and economic sustainability (Turcu 2012). It is also, or foremost, the

development that contributes to global sustainable development, with its environmental awareness, inter-generational equity, social wellbeing, and geographical equity combined with economic growth (Haughton 1997). There's been a lot of scientific arguing about the term 'sustainable urban development' or 'urban sustainability' but for all different definitions, these term includes environmental aspects (like lowering greenhouse gas emissions or waste amounts), social aspects broadly defined as better quality of life and economic stability and sustainability, which may defined as access and availability of local jobs, business activity, local training and skills. Measurement of urban sustainability in the form of indicators, is compliant to some extent with aims of sustainable buildings, i.e. environmental sustainability of urban communities includes careful resource exploitation – energy, waste, water which are also important categories in green-buildings certification schemes. In terms of buildings' location the next overlap would be infrastructure category, especially public transport. Among discussed features of 'sustainable urban development', some are generally agreed upon: emphasis on reduction of private (car) transportation and improving public transportation, supporting other active transportation modes like walking and cycling, limiting urban sprawl and promoting inner-urban dense development and mixed-use areas (Gurran, Gilbert, and Phibbs 2015). Accessibility by public transportation and supporting other, ecologically non-destructive modes of transportation are thus included into criteria of green buildings evaluation (green certification schemes, like BREEAM or LEED).

Locational choices for sustainable buildings

The process of making location decisions by real estate investors, involves considerations of numerous factors, important for the investors and facility users. The set of factors is flexible, dynamic, depends on the type of industry and overall conditions for business (Karakaya and Canel 1998). Real estate industry considers location as one of crucial variables in achieving investment profits, and consideration of several location factors and specific qualities of a company, normally precedes final selection of location site. Locational characteristics refer to the selection of *general location* that includes macro- and micro-environment for conducting business and *specific site (exact location)* for investment. Selection of exact location happens in the final stages of location selection by commercial organizations and crucial decisive attributes include (Aarhus 2000) cost factors (land, construction); ease and speed of administrative procedures of issuing construction permits and other required administrative consents; physical features of site and/or building (e.g. size, shape, flexibility of development, surroundings), public visibility.

Rymarzak and Sieminska (Rymarzak and Siemińska 2012) provide more detailed classification of factors affecting site selection, comprising of cost factors, physical and spatial (geographic location) factors and characteristics of accessibility and traffic. More than generally acknowledged location attributes affecting site selection, decisions to locate sustainable buildings, consider some additional factors or scores conventional factors differently (e.g. abundance of parking space is not crucial for high performance buildings). In selection of site for sustainable construction, strong emphasis is placed on accessibility by environmentally friendly modes of transport: public transportation, bike, walking, to replace negatively impacting

environment car transport and provision of amenities for pedestrian, and bikers, or car-poolers and electrical vehicles. This even leads to promotion of sites where low number of parking spaces is allowed (reducing parking footprint in LEED certification scheme). Strongly promoted (and highly ranked in environmental building assessment schemes) is selection of brownfield land over greenfield, and protection of natural habitat and eco-diversity, and enhancement of ecological value of a site. Apart from purely ecological features or transportation, the functions and density of surroundings, adding to diversity of uses in the area are the advantage.

Investigation of actual locations of green buildings, support the assumption that spatial diffusion reflects these features of sustainable buildings locations. Diffusion of LEED certified buildings (Braun, Cajias, and Bienert 2014) demonstrates locational pattern of higher share of these buildings in prime urban locations (best office locations in each respective city, well accessible with various transportation means, visible, in the functionally well-developed area, with access to amenities and facilities, maximal intra-metropolitan rent value) (Braun and Bienert 2015). The share is disproportionally higher in prime locations and the diffusion pattern is centrifugal (hierarchical), and with increasing saturation of the market in prime locations, the distance to CBD is growing but still prime locations are definitely more 'green buildings' saturated'. Similar conclusions conveys the research on distribution of green buildings in Germany - they are located closer to CBD in cities with over 500 thousands inhabitants, and tend to locate close to each other – spatial concentration of sustainable buildings within 'green clusters' surrounding CBDs, the biggest concentration of within 1-2 km from city center (Maier, Ciora, and Anghel 2014). These effect of clustering has been also noted in USA (Kaza, Lester, and Rodriguez 2013) sustainable buildings, located close to one another, demonstrate spillover effect. Sustainable locations or locations of sustainable buildings contributing to the benefits of local communities (ecologically, economically) should comply with criteria of sustainable urban development.

Public policies and green building promotion

Sustainable office construction, that forms one of major trends in commercial property markets, brings advantaged to stakeholders (investors, users, tenants, local government, local community) in various forms, that compensate the costs of sustainability. The occurrence of benefits generated by green (rather than traditional) buildings has been documented in several research worldwide and described in an extensive body of literature e.g. (Zieba, Belniak, and Gluszak 2013) (Galuppo and Tu 2010) (Malkani and Starik 2013) . Benefits of sustainable office buildings include:

- *for investors* (economic, financial, image, marketing benefits of responsible investing and sustainable buildings' development, lower investment risk)
- *for users and tenants* (health, wellbeing, functionality, lower maintenance costs, high standard, better conditions for employees)
- *for local community* (limiting negative impacts on the environment, respecting the needs of a neighbouring community, including transportation issues into location selection, environmental and social concerns of investors)

- *for local government* (property and income taxes, less environmental burden, investments respecting local transportation and communication conditions, creation of more 'local community friendly' structures generates less protests and burdens, social responsibility of investors should result in more smooth cooperation with local government, respecting local laws and administrative or planning requirements).

The overall benefits of green real estate and responsible investments in property markets, result in increasing volume of sustainable commercial buildings and in growing number of policy-makers incentives to encourage more of this type of construction. Still, in scientific debate there's ongoing discussion on motivations driving sustainable real estate investments. The development of sustainable buildings stock might be contributed to market and non-market drivers. Market motivations include financial, economic, image benefits for in investors and tenants: higher value of a property, higher rents, lower maintenance costs, lower risk, lower turnover ratio among tenants, lower vacancy ratios, better working conditions and wellbeing of building users, favorable opinions (extensive literature proves occurrence of the benefits). Non-market reasons for the development of the sector of sustainable construction and green real estate include various public policies' instruments, used to steer and encourage development of the built environment into direction which is beneficial for local communities, natural environment and local economy and habitat.

Policy instruments formed at global (e.g. UN guidelines), national, local, international (EU policies) levels, could be arranged into incentives and requirements (or regulatory policies - spatial planning) as well into legislative (affecting all firms and institutions) and executive (affecting public agencies/institutions) tools (May and Koski 2007). The incentives, of positive character, generally consists of three types of encouragements: administrative, fiscal and technology support (Choi 2010a), though, they may take the form of negative incentives – fees, penalties, compensations and on the market level, public policies significantly affect the green building development (Zuo and Zhao 2014).Green buildings policies have several goals related to sustainable buildings, among others – encouragement, via legal and regulative instruments for sustainable buildings development (Shi et al. 2014).

Further justification for public policies promoting sustainable building via planning tools (delimitation of investment sites) comes from research proving that, large share in investors' motivations to realize green building is related to non-economic factors of *social influence* and *facilitation conditions* e.g. availability of information, technology of construction, land (Malkani and Starik 2013). Creation of various instruments to promote green construction supports diffusion of green buildings technology in real estate markets (Głuszak and Zięba 2014).

And even though the incentives and ideas of green real estate came from non-governmental organizations like Green Building Council, the public policies possess probably the most influential tools to promote green development. Financial incentives are costly, should be carefully administered, executive orders are quick but cannot be applied if there's no proper legislation facilitating them. Though legislation tends to be dissolved in political debates. Leading by example (e.g. green public buildings) is a good path to raise awareness (R. Simons, Choi, and Simons 2009). But for the maximum effects of public policy tools in promoting local sustainable development, integration of tools and policies in the form of Integrated Planning

Approach is the solution. Applying integrated approach may lead to significant reduction in energy use (e.g. 25% as in the case of Jinan development plan), lower pollution (from car transport) (Shirgaokar, Deakin, and Duduta 2013). The approach should integrate building codes, land use planning, urban and spatial design, transportation policy to improve environmental conditions of urban areas. Similar concept of 'policy-mix' for achieving energy efficiency via application of multiple policy instruments in a complementary and integrated way, with active participation of stakeholders has been discussed by Mahzouni (Mahzouni 2015).

Most powerful and efficient requirements policy tools are regulation provided in local development planning (zoning maps) that nominate location of urban functions in accordance with sustainable urban development guidelines. Spatial, urban planning coordinated with local strategy for sustainable development and sustainable building policy directly affects locational decisions of developers and tenants (Aarhus 2000). This type of regulatory policies – nomination of areas for new developments, requirements referring to 'green features' of buildings are direct and effective tool (Choi 2010b) The focus on local administration level and its role in promoting sustainability has been present in several international initiatives and emphasis on local planning (changes to promote sustainability) is to be found in critical for sustainability development documents, such as Agenda 21 (Bayulken and Huisingh 2015).

Zablocie case study

The research study consists of two phases: the first stage provides information about the most suitable areas for green office buildings location, considering BREEAM criteria, the second stage includes the analysis of the local development plan in sustainable investment context.

The area of analysis covers the district of Zablocie, located on the outer fringe of the city centre, at the river banks, former industrial base for the city of Cracow, is the area where intensive commercial and residential developments has been taking place for the last 10 years. After 1990 and political and economic transformation of Poland, the industrial activities in the district ceased and an urban fallow remained. Contemporary developments may be ascribed to passage of Local (Zoning) Spatial Development Plan and Local Regeneration Plan in 2006. Although spatial development plan was the most significant, the district wouldn't have transformed so much without the construction of new bridge on the Vistula River and following launching of new tram line, that connects the district and southern parts of Cracow with its centre and eastern-northern part of the city. The second reason for choosing Zablocie for the analysis is that commercial developments (offices) within last 8 years resulted in over 100 000 square meters of modern office space, of which most has been awarded already or is in the process of certification for BREEAM green certificate. Considering that total office stock in Krakow amounts ca. 800 000sqm, this makes the district of Zablocie an important 'office space hub' in the city.

The basis for analysis of best "sustainable locations" for office buildings in the district of Zablocie were BREEAM environmental assessment method for buildings. BREEAM criteria are applied worldwide to certify sustainable buildings. This is also the most commonly used

environmental certification scheme in Poland (Services and Certification 2015)[1]. BREEAM (Building Research Establishment's Environmental Assessment Method) is the assessment method used to measure environmental performance of buildings against a set of ten categories and to produce an overall score of a building, awarded with label: Pass, Good, Very Good, Excellent or Outstanding. Evaluation categories include crucial for measurement of buildings environmental performance, thus its sustainability (Breeam 2012):

1) **Management:** Commissioning, Construction site impacts, Building User Guide
2) **Waste:** Construction waste, Recycled aggregates, Recycling facilities
3) **Health and Wellbeing:** Daylight, Occupant thermal comfort, Acoustics, Indoor air and water quality, Lighting
4) **Pollution:** Refrigerant use and leakage, Flood risk, NOx emissions, Watercourse pollution, External light and noise pollution
5) **Energy:** CO2 emissions, Low or zero carbon technologies, Energy sub metering, Energy efficient building systems
6) **Land Use and Ecology:** Site selection, Protection of ecological features, Mitigation/enhancement of ecological value
7) **Transport:** Public transport network connectivity, Pedestrian and Cyclist facilities, Access to amenities, Travel plans and information
8) **Materials:** Embodied life cycle impact of materials, Materials re-use, Responsible sourcing, Robustness
9) **Water:** Water consumption, Leak detection, Water re-use and recycling
10) **Innovation:** Exemplary performance levels, Use of BREEAM Accredited Professionals

Majority of categories evaluates the design of a building, one is focused on the wellbeing of users but only two are elaborated to assess spatial aspects of a building – its location and impact on environmental features of an area and connections with wider urban surroundings (features important for urban sustainability) – transportation. For the purpose of analysis we decided to select category that reflects the focus on sustainability features of building's locations, i.e. transport. Land use and Ecology category, which certainly is relevant, cannot be measured due to lack of spatial information.

Locations, which are awarded highest scores in environmental assessments schemes and achieve corresponding recognition in sustainable urban development concept, are locations favoring public transportation and other active and non-car transportation modes (rail, bike, walking). Accessibility to public transportation is appreciated by real estate industry and ranked as an important for users and environment characteristic of green building (R. A. Simons, Robinson, and Lee 2014). Increased use of car transport is the function of accessibility to the main roads system, to free parking; accessibility to public transport, and higher share of employees living walking or bicycling distance to work decreased uses of car transport. Limiting

[1] 81% of 'green certificated' awarded to commercial buildings in 2015 are BREEAM certificates according to Colliers International. Zielone budynki w Polsce 2015 Certyfikacja w liczbach. Building Consultancy Services, Green Building Certification Warszawa 2015

use of car in work travels is one the criteria of sustainable buildings certification. These further justify the selection of criteria for spatial analysis.

To carry out site selection process, four transportation criteria were adopted from BREEAM methodology (Table 1): public transport accessibility, public transport service frequency, access to amenities and car parking capacity. The first step of spatial analysis included geodatabase creation which involves collecting data from different sources and processing them. Local spatial management plan was obtained from Spatial Planning Agency and converted from CAD file to shapefile. Road network, railway network and location of address points came from OpenStreetMap. All of the analyses were performed using ArcGIS Desktop with Network Analyst extension.

Table 1. Transportation criteria adopted in the site selection analysis

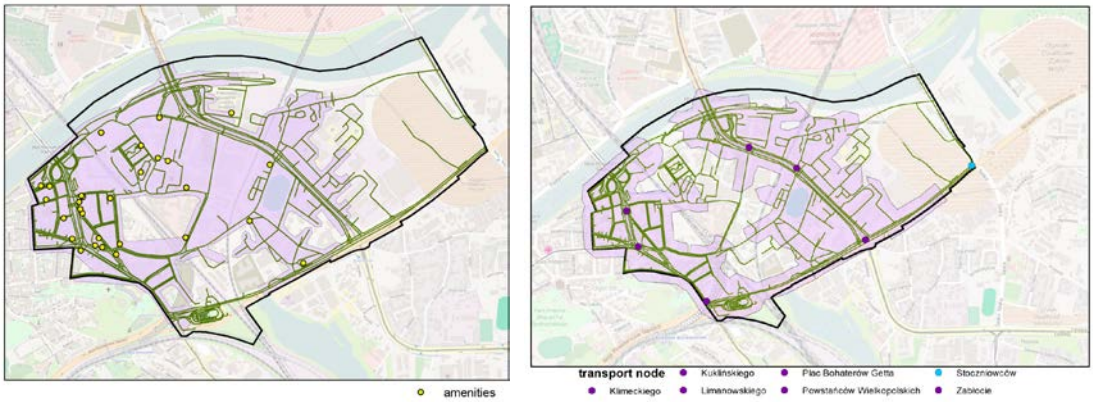
Category	Assessment criteria	
Public transport accessibility	Building entrance within maximum 500 meters walking distance from public transport node	Road and tram network analysis.
Public transport service frequency	Minimum service from transport node: once in 15 minutes at peak times (7am – 10am; 5pm – 7pm) in direction of local urban center, on working days and once in 30 minutes at peak times (7am – 10am; 5pm – 7pm) in direction of major transport node (local and regional infrastructure systems), on working days.	Analysis of bus and tram timetables from all transport nodes in research area.
Access to amenities	Maximum distance from post office and food court/shop – 500 meters. Distance from 2 additional types of following facilities – less than 1000 meters: bank/ATM, hairdresser, medical center, pharmacy, dry cleaners	Geolocation of selected facilities and service area analysis, which indicate areas encompassed by specified range (radius).
Car Parking Capacity	Maximum 33 parking space per employee.	Analysis of the local spatial management plan regards the service parking rules.

Source: own studies based on "BREEAM Europe Commercial 2009 Assessor Manual," no. 1

The district of Zabłocie is served by seven transport nodes: Kuklińskiego, Plac Bohaterów Getta, Klimeckiego, Limanowskiego, Powstańców Wielkopolskich, Stoczniowców and Zabłocie. In order to evaluate public transport service frequency, timetables from all transport nodes were analyzed. First category requires frequent transport service in direction of local urban center and in direction of major transport node. Six of seven transport hubs fulfilled the requirements. Despite that Zablocie node is supported by five bus lines (cf. Klimeckiego, Plac Bohaterów Getta has only 3 tram lines) but only one line departs to the city center (once in 20 minutes), thus it was rejected from further analysis. The second stage included public transport

accessibility which involves area delimitation at a distance of 500 meters along communication routes (fig. 1).

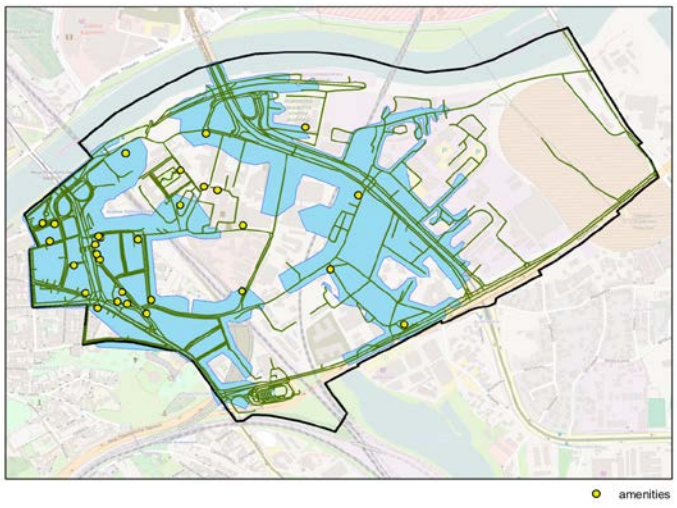
Figure 1. Public transport accessibility, Figure 2. Access to amenities



Source: own studies, data from OSM

Another criterion adopted for the analysis was access to amenities, which requires maximum distance from the post office and food outlets/grocery shop in range of 500 meters and from other facilities – less than 1000 meters. The first step included creating the database of amenities localizations defined in the criterion and the next step of research was conducted using service area analysis (ArcGIS Network Analyst extension). As a result authors obtained map of facilities impact areas depicted in fig. 2.

Figure 3. Suitability map in the study area



Source: own studies, data from OSM

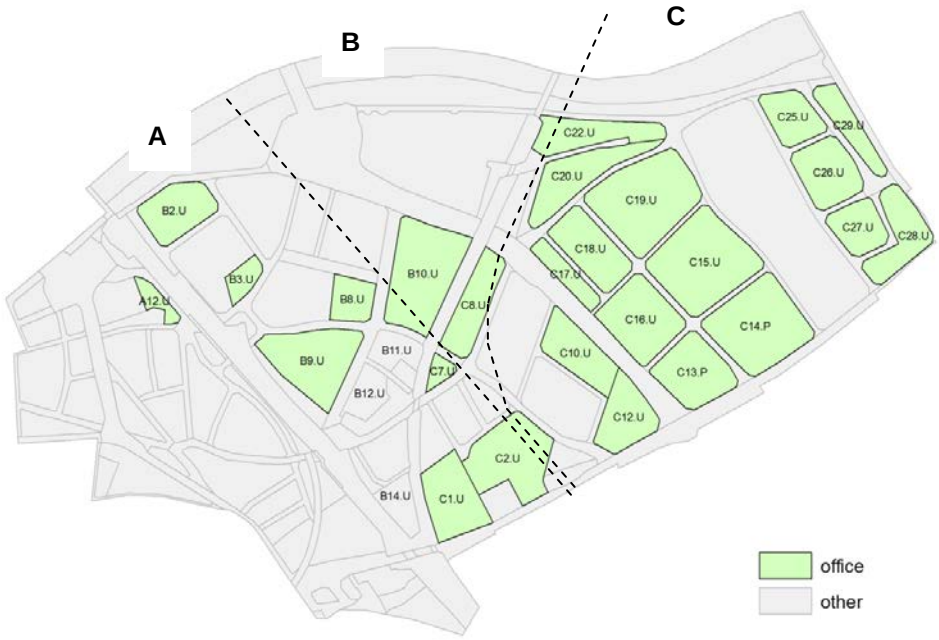
The last step on this stage of analysis was delimitation of the most suitable areas based on one of the Boolean overlay procedure – intersection. Figure 3 shows suitability map of Zablocie district that cover three main criteria: public transport accessibility, public transport service frequency and access to amenities. Authors find it very important to take into consideration more sustainable development factors, suggested in BREEAM methodology, i. e. those concerning bicycle facilities. Unfortunately limited access to the data made it impossible to expend the analysis with alternative modes of transport aspects.
The last criterion was the maximum car parking capacity, which limits are regulated in local development plan and will be discussed in the next section.

Local development plan's "green locations" - summary

Local development plans, created by local governments according to Law on Spatial Planning and Management (*Ustawa O Planowaniu I Zagospodarowaniu Przestrzennym* 2003), are facultative, i.e. there is no obligation to prepare them, the whole urban area does not have to be covered by plan but when enacted they have to be respected by investors and administrative bodies issuing building permits. Local development plan determines the function of the area covered and all new construction must by compliant; it also defines the intensity of new construction, its technical and functional features and requirements (height, built-up area of the site, allowed/minimal or maximal amount of parking space), natural environment protection rules, defines protected areas (natural or cultural), it has to comply with the rules of protection and shaping of spatial order and the latest includes sustainable development concept into spatial order principles. Local development plan must consider local transportation and technical infrastructure conditions. Previous researches indicates that investment activity in major cities areas covered by local plans enhance investment activity (Kania, Telega and Węgrzyn 2014). Thus, local development planning (zoning maps), being the major spatial policy instrument of local government, can be a powerful tool to promote sustainable buildings development in Poland.
The area of Zablocie district, covered by the spatial development plan equals 175 hectares and has been divided into three functionally different parts (fig. 4):
A – the smallest and most developed, with dominating residential function to be preserved and some old housing (also historical); very little undeveloped land.
B – the most important in this analysis and also the most transformed part of the district. The area almost entirely industrial before transformation. As designed in the development plan, the area evolved into housing and commercial – mostly office, with some cultural and educational functions. Still provides some undeveloped sites.
C – the biggest part of the district, least developed before and after transformation. Dominated by warehouses, on the fringe some green areas (family urban gardens). The functions planned in the zoning map include commercial, residential and services.
Office buildings, according to local plan's principles, can be developed on each of twenty six areas (47,6 hectares) depicted on figure 4. The total area of planned land use for commercial

purposes equals over 47 hectares, but conditions of development and spatial management in every part differ from each other (i. e. terms of build-up intensity, height of buildings or other acceptable land-uses).

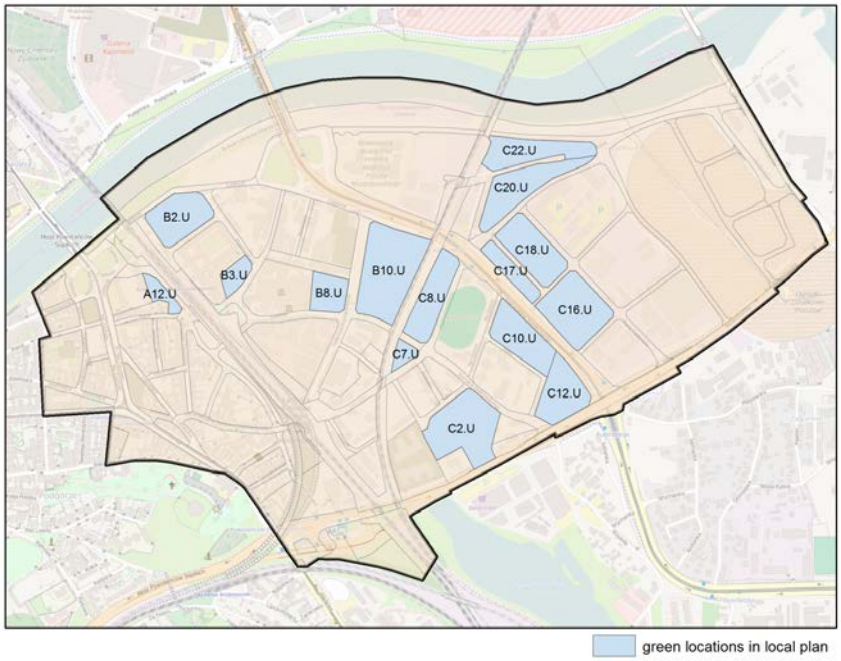
Figure 4. Office locations in local development plan



Source: Spatial Planning Agency

The criterion of the car parking capacity was regulated in local development plan as the rules of parking service. The parking policy was divided into three parts (A, B, C). For retail and service buildings located in Zone A, there should be maximum 15 parking spaces per employee and 8 parking spaces per 1000 square meters of usable floor space. In Zone B there should be no more than 25 parking spaces per employee and 15 parking spaces per 1000 square meters of usable floor space, and adequately in Zone C – 35 parking spaces per employee and 35 parking spaces per 1000 square meters of usable floor space. The adopted maximum parking capacity in local plan represents the upper limit, that cannot be exceeded and eventually the developers during the design process, can significantly reduce it. Concluding, all zones met BREEAM requirements.

Figure 5. "Green locations" in local spatial development plan



Source: Spatial Planning Agency

In order to verify in what extent local development plans (zoning maps) facilitate location of sustainable office buildings on sites that are best-choice using the criteria of green buildings' certification, authors tested which substantial part of suitable areas covers areas for the office buildings in the local plan. The results can be seen on figure 5, where highlighted areas in local development plan conducive green buildings development.

The important obstacle for the creation sustainable spatial policy facilitating and favoring green developments is the public transport infrastructure condition and the quality of transport services. On the research area, despite of the fact that almost one third of development plan was dedicated for commercial purposes, it is hard to find any mention of the public transport accessibility improvement. The similar situation concerns access to different types of amenities. The highest concentration of food courts/shops is in older and most developed part of the district (zone A).

However car parking capacity rules indicated in local development plan are more restrictive than those adopted from BREEAM methodology. Another premise enabling an improvement is future opening of the Zablocie railway station and slow development and broadening access to facilities, which usually occur in newly constructed office buildings.

Authors are aware of the fact that the research study didn't include many important factors (i. e. alternative modes of transport, pedestrian and cyclist safety or reuse of land) that can affect test results. The criteria selection was dictated by limited access to data or difficulties in data processing. However, further studies will be extended by additional LEED (Leadership in Energy and Environmental Design) green building certification criteria.

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