Outdoor hotspots as a tool for enhancing healthy lifestyles of ICT users Design and development principles

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Abstract – *The authors of this presented study formulated research assumptions that the Internet and new technologies may interact with the landscape architecture. The presence of hot spots in public spaces can help to increase the amount of time spent outdoors, improve relationships between users and enhance their quality of life.*

The conducted research included a review of literature related to ICT applications, as well as a survey of global design solutions concerning the introduction of ICT components into public spaces. Moreover, the study was based on the results of previous research by the same authors on behaviour and social expectations of ICT users in relation to leisure spaces.

The research results let us frame design guidelines and principles for development of outdoor hotspots. The developed guidelines apply both to technological and spatial solutions, including the following aspects: the location of hot spots, rules of design of urban furniture, vegetation, pavements and architectural details.

Keywords: urban public spaces, green spaces, Wi-Fi, open space design, human well-being, ICT

I. INTRODUCTION

In today's world human activities associated both with work and leisure are commonly based on the use of the Internet and require the application of modern technologies. For many people, spending time in virtual reality results in less time spent outdoors, which can create a negative impact on their health. The way to counteract the effects of this situation is to use solutions enabling at least a partial shift of activities, associated with entertainment, learning or work, outside the buildings. At the same time, public spaces, including urban green spaces, in most Polish cities are not designed to meet ICT users' expectations related to quality of urban space [1]. The elaboration of design guidelines and principles for the development of hotspots in public areas, including urban green spaces, could enhance the development of top quality urban public spaces reflecting the expectations of modern users.

Moreover, the authors also assume that those ICT innovations in urban public spaces might encourage people to spend more time outdoors. Thus, the aim of the study was to elaborate design guidelines and principles for the development of hotspots in public areas, including urban green spaces. The performed study was aimed at the exploration of a range of opportunities to encourage people to use public open spaces as a place for working, studying or relaxing.

II. MATERIALS AND METHODS

In order to study issues related to the benefits of staying outdoors a literature review was carried out. Moreover, the study was also based on the results of previous research by the same authors on behaviour and expectations of ICT users in relation to leisure spaces. Taking into account both the results of the aforementioned study and the findings from the literature, we were able to identify the characteristics of places designed to encourage the hotspots users' presence in public spaces, and in such a way, to increase their abundance. These included the determination of undesirable types of users surrounding the hotspots, aesthetic conditions, functionality, signal quality, the presence of vegetation, the feeling of space through the senses. On the basis of the collected data and own preliminary research, friendly spatial features ensuring the presence of ICT users in public spaces have been specified. Based on the determinants of the hotspots' setting, spaces considered to be favourable and unfavourable for the hotspots' location were identified. The guidelines for the proper design of hotspots in outdoor public space have been formulated, taking into account the specific users groups, eliminating inconvenience in the use of mobile devices, unfavourable weather conditions, determining the most advantageous hotspots' size, furnishing and features of building materials.

III. RESULTS

The design of hot spots zones linked to attractive infrastructure can be a response to rapid technological progress, the desire to be up to date, and at the same time the need for being involved in society. People are interested in staying outdoors and moving the technology there. According to research by Kołody ska (2016) [1], over 25% of hotspots users in parks admitted that they did not visit these places before the wi-fi signal transmitters were installed, and 70% reported that they have been going more often since there is available Internet. The fact that the presence of the Internet is an important factor encouraging relaxation in the open air results from research carried out in the US, where 75% of respondents admitted that they have a choice between two similar places with similar arrangement of space and choose the one where wireless Internet is available [2]. It is highly probable that the users in Poland would behave similarly to those in the US.

Basing on the literature review, we can summarise that besides the obvious possibilities mentioned above, this type of place could provide:

- better integration, socialising, intensification of contacts between people [3];

- an increase in the involvement of society [4];
- an increase in the quantity of the stimulating impulses;
- collection and exchange of experiences, ideas, observations, broadening of one's horizon [3];
- taking inspiration from the environment;
- change in the way that relationships form, creating a social platform wherein we live in a variety of environments [5];
- reduction of social inequalities and the prevalence of Internet access [6];
- finding the reason to go out of the house, changing the environment that provides an extension of the private space; and
- domestication of additional space for people who cannot live without technology, and to provide them greater contact with nature (the Internet is currently considered by some people as being solely a virtual public space, replacing the presence and contacts in the real world).

The feeling of being part of the community increases the motivation to act, as the sight of other busy people motivates and inspires. Stimulation takes place on many levels and causes the rich sensorial experience. Number of impulses and situations becomes unrestricted. The presence of other people is the greatest value of open public spaces [7]. Mobile Internet users are able to focus on the undertaken activities and they do not mind moderate noise and activity of other people [4]. Creating arranged hotspots in an open space could therefore potentially have a positive impact on social relations, human functioning, and an increase in the frequency of outdoor activities.

IV. RECOMMENDATIONS FOR HOTSPOT DESIGN – SELECTED FEATURES

The city is a set of different-scale objects. People-friendly spaces are special, easily distinctive from other, surrounding areas. Well-organised cities are characterised by an innovative environment and meeting places create their identity. These are spaces that meet the contemporary human needs, result from personal preferences and individuals' lifestyles. A friendly city is a hybrid city that combines multiple aspects of life and human functioning. Modification of urban space in accordance with the requirements of the information society is a dynamic process, dependent to a great extent on the prevailing fashions and trends.

The test of friendliness and usefulness of the public space and its degree of popularity is its number of users. According to Petelenz [8] the occurrence of interest can be enhanced through:

- the application of spatial dominance or accentuation;
- the creation of a favourable climate for prolonged use;
- paying attention to the aesthetic quality of the place;
- providing extra functionality that in turn enables the consumption of space; and
- the application of facilities for the disabled.

Types of users

The design of surroundings should be suitable to the age and, consequently, the users' preferences. A group of divergent interests from the Internet users include: children, mothers with newborns and rowdy youths, especially those practicing sports. Their presence would result in a lack of comfort due to excessive noise and disturbance that makes it hard to focus on the activity performed using the portable devices. Therefore, one should avoid locating Internet access points in an environment of playgrounds and the hot spot equipment itself should not invite activities such as skateboarding, roller skating, etc. The presence of users and their distribution within the area of the hotspot determines many factors. First of all, those important are:

- weather conditions;
- signal strength;
- the possibility to charge the mobile devices;
- comfortable furnishings;
- habits of the inhabitants, the culture of the region;
- opinion, the reputation of the place;
- the presence of other people;
- aesthetic quality of the space;
- usage charges; and
- the possibility of privacy [4].

In the design process, particular attention should be given to provide the highest possible protection against unfavourable circumstances and at the same time to expose the natural values of the place.

Aesthetics

The quality of the space determines, among other things, its visual qualities and ideological relationship with the performed activities. An interesting idea, referring to the character of the place and a virtual space, seems to be an adoption of the environment "pixelation" concept. The project is based on the assumption of having a simple square module combined with the idea of the free Internet, giving the opportunity to clear space identification (Fig. 1). Therefore, each zone should be designed in a way to achieve a sense of intimacy, as a coherent composition, with a uniform character. For that reason, the presence of distinctive details and elements is important as well [9].

The hotspot space should be viewed as representing the high aesthetic qualities and functionality. Therefore, in the hot spot zone design, pastels and muted colors, low ceilings, moderate shade and brightness should dominate. Spaces should be free of chaos, but cannot be too sterile. People feel comfortable when they can benefit from a stable and a sturdy equipment (Fig. 2). Fulfilling those requirements, an increased users frequency in such site occurs [10].

Fig. 1. The shading pergola with the geometrical design, which was part of "pixelation" style.
Source: http://architektura.muratorplus.pl/zycie-w-architekturze/2015/plac-w-gorze-pulawskiej/1215/

The optimal solution is to create places where city-dwellers can find peace and quiet, contact with the nature, as well as access to services such as the Internet. The following is an example of the hotspot with vegetation on the roof, as an example of the visually and functionally friendly place (Fig. 2).

Fig. 2. Multi-functional hotspot in the public space, design created by Mathieu Lehanneur.
Source: http://www.jcdecaux.com/en/Innovation-Design/JCDecaux-s-Intelligent-Street-Furniture

Functioning

The location of a designed hotspot makes sense in a place where conditions are stable and allow undisturbed propagation of the signal. The entire design should harmonise with the environment, and the proportion between free area and equipment should be proportionate. The minimum size of the furnished hot spot should be about 16 x 16 metres. This is due to the possibility of a clear designation of zones for users having various opportunities for spatial usage.

The optimum size of the surface area is approximately 30 x 30 metres, because this area will allow for the implementation of all zones (e.g. individual silent, subdued individual, loud group, subdued group, fast access); at the same time it does not dominate the surrounding area and it would be positively perceived by the users.

Quality of the signal

Actually, there is no upper limit of the hotspot size, except that one should be aware of providing adequate Internet signal coverage of a space. In order to extend the range of waves additional access points should be placed so as to overlap the signals. The signal strength determines the location of the users and their distribution in space. User activity depends on the connection quality, but one should not forget that the needs of users are also not identical. A zone with stronger signal attracts users who use multimedia, and those whose main activity does not require such a good connection may stay further away.

Vegetation - selected features of plants in the hotspot's design

The area surrounding access points to wireless Internet is a specific type of space. Vegetation has aesthetic and compositional value and properly shaped it can provide shade and determine the intimacy of individual zones of the hotspot. It serves as a visual and functional determination of the border. In general, trees and other plants improve the comfort of staying in the hotspot surroundings. The most important function of greenery in the hotspot's environment is their impact on the space microclimate. This function consists in the reduction of the temperature amplitude, sun protection, shaping the circulation of air, protection from the wind and increasing humidity (all of these characteristics are desirable). Furthermore, the hygienic and filtrating role is also important from the point of view of human functioning.

At the same time, plants in the environment of designed hotspots should not:

- cause severe allergies, due to the increasing percentage of allergic people [11];
- have an intense smell, but should be neutral;
- produce fruits that may attract animals or contaminate the environment; and
- in the period of hotspots' largest occupancy, attract insects, and indeed should repel them. It is recommended to design composition of plants flowering in spring and autumn, in order to minimise the presence of insects.

The location of hotspots in parks is justified by technical reasons. Vegetation can serve important functions directly related to the functioning of the site access to the wireless network and help ensure optimal conditions for the use of mobile devices. Proper selection of plants can regulate the rate and extent of radio wave propagation, define the shape and size of the hotspot by directing waves and modelling the signal's propagation, while preventing reflecting waves from the other field obstacles [12]. For the design of surroundings, Internet access points can be divided into five categories of vegetation: tall trees with dense foliage, tall trees with sparse leaves, shrubs having an average of dense foliage, shrubs having an average of sparse leaves and low vegetation with dense foliage. Separate categories have an important influence on the hotspots.

According to a study conducted in San Francisco for the 802.11b (2.4 GHz) network operating system, trees weaken the signal strength, but do not lower it below -75 dBm (minimum value required to maintain connectivity of the Wi-Fi). They do not cause the need for additional AP [13]. Currently, the most widely used 802.11 g/n are stronger and have a greater range, which further reduces the issue of potential conflict that trees may have for the disappearance of a signal. Moreover, the well-planned vegetation can help efficiently distribute the Wi-Fi signal and reduce reflection and overlapping of the signal.

The feeling of space and visual stimulation

Nowadays people are sensitive about their privacy and territory. It is therefore necessary to take into account the way space is felt in the process of creating guidelines for the planning of a new hotspot, as the creation of a sustainable surrounding is the primary way to organise group and individual activities. The following describes the important conditions in designing a properly functioning hotspot.

Sight

Through the sense of sight we perceive about 80% of impulses, so it is important to design hotspots that use visual communication and identification of the place. It is very easy to remember a specific place, with a distinct structure. A colour has an important role in creating space identification.

The perception of colour varies for each individual user, but there are some frameworks that can be generally recognised. The use of colours and their combinations gives the possibilities for the creation of a mood and effect on the positive perception of the object by an individual. Thanks to applied colours a project can easily change accents in the space [13].

It is important to take into account the range of the field of view of a user. Providing the ability to control the site by distant view increases the frequency of the space's use. People use the place only when its borders are visible and they can control the surroundings [14]. Keeping a distance of approximately 20 metres people are able to freely observe others and recognise faces. The distance of 3.75 m guarantees the perception of most of the details and keeping a safe public space. People are able to function properly and work while keeping a distance ranging from 1.2 to 2.1 metres. These distances should be taken into account when designing the surroundings and arranging hotspot seats [10].

In addition, from a psychological point of view people in the public space feel comfortable if the seats are oriented towards others, allowing the observation of potential threats, but also to satisfy curiosity.

Hearing

Designing hotspots' surroundings require isolation from intrusive and unwanted sounds. The sound levels up to 35 dB (normal conversation), if constant and non-violent, provide comfort of staying in a place. The voice of others is clearly audible from a distance up to approximately 7 metres. At a distance of 35 metres, we only hear that something is happening and the human brain does not focus on the message. Stimulating, but also calming, may be the sounds of nature.

Smell

The sense, which reacts at close distance is the sense of smell. The human sense of smell is quite weak and fragrances of low and medium intensity may usually be felt at a distance of approximately 2-3 metres. Strong odours are noticeable from further distance, so it is not recommended to arrange hotspots in the environment exposed to intense odour stimulations. An increasing number of people are allergic, so it is important to choose plants that are known as non-allergic plants. These factors are important for the design of places to relax and place seats.

Somatic senses

Factors such as temperature and touch are immediately felt by the human skin. Therefore care must be taken to properly choose the type and quality of materials equipping the hotspots. Hotspot users will mainly interact with the seating and tables. For a comfortable stay and the undisturbed use of such sites, pieces of equipment require the use of materials that will be comfortable and adjusted to human ergonomics, that will provide air circulation, that shall not be excessively dissipated, and that will not cause injury (such as splinters from unpolished surfaces) [10].

V. DESIGN GUIDELINES

Basing on the above survey of recommendations, the guidelines for hotspots design were formulated (Table 1). Building hotspots with related, additional equipment is not justifiable, or necessary, everywhere.

In typical transit places, or exceptionally busy ones, a better solution is to use only marked access points. If working conditions are unfavourable and individuals find it hard to concentrate there will be brief and spontaneous single user sessions, regardless of the surrounding equipment. Also, spaces that are not reputable are not suitable for the design of hotspots. Other factors will not affect the increasing number of users [10].

TABLE I. HOTSPOTS DESIGN AND DEVELOPMENT PRINCIPLES

ISSUE	CONDITIONS AND FINDINGS	DESIGN AND DEVELOPMENT PRINCIPLES
Users	Number of mobile Internet users increase every year.	• Design/arrangement of hotspot area should consider its development and increase number of users.
	Hotspots are used differently and this is related to users' expectations of Wi-Fi signal quality.	• Design/arrangement of hotspot area should take into consideration users' expectations and Internet usage without any interferences. • Creation of silent or loud zones related to different quality of the signal, arrangement and equipment.
	Smart phones are more frequently used than other mobile devices (e.g. laptops, tablets) in public spaces.	• The space of the hotspot should consider users of different mobile devices and their typical behaviours in relation to size of the space.
Disadvantages of mobile devices' usage	Lack of power supply prevents working effectively, cuts down time or completely eliminates potential users of hotspots.	• Installation of electric sockets and USB charging ports.
	Sunlight reduces much visibility of mobile devices' screens.	• Application of shaded architectural elements and plants.
	Users appreciate privacy and feel comfortable when other users do not look at their mobile devices' screens.	• Limitation of foot traffic behind a hotspot user's back. • Use of protective plantations and low-scale architecture to ensure privacy.
Weather conditions	Weather conditions determine time spent by users in comfortable organised hotspot area.	• Protection from negative weather conditions prolongs time of using hotspots, e.g. roofing and pergolas protect from sun and rain, insulating planting protects from wind and separates zones from others.
Equipment	Well and comfortable equipped hotspots for individual and common work are desired in open spaces; people wish to move their activities to new places (other location than home and place of work).	• Application of ergonomic and comfortable urban furniture increases quality and extends time spent by users outdoor. • Creation of places for work as well as for social meetings outdoors.
	Users need to arrange the space, and adapt it to the number of people and type of activity.	• Use of modular equipment allowing individual arrangement of the space related to individual users' needs.
	Equipment determines time spent by users in a hotspot area regardless of their physiology.	• Application of supplementary equipment (e.g. toilets, security cameras) in the surrounding area of a hotspot increase the quality of use. • Location of hotspot not far from food support (coffee shop, bar, etc.).
Materials	Materials of high density and metal construction causes disturbances of signal propagation.	• Use of low density and transparent materials. Protection of metal elements by plants.
	Plants do not limit propagation of radio waves. Walls of greenery counteract radio waves' overlap and direct them.	• Adequate planting composition contributes to the correct distribution of radio waves.
Health condition (comfort/life quality)	People spend more time at home and work at the cost of spending time outdoors that has a negative impact on their health condition.	• Organisation of as many as possible places for different activities outdoor to invite people there - creation of rest, work and learning places outdoor.
	People more frequently assume sitting or a recumbent position in enclosed spaces.	• Ergonomic equipment of hotspots allows individuals to assume comfortable, varied and healthy positions.

There will not be a need everywhere for the comprehensive implementation of the whole project, with all zones. Depending on the recognised needs, the hotspot surroundings should be adapted and reasonably planned. It is desirable to locate equipped hotspots in locations where various mixed functions are present, e.g. housing, services, recreation, etc. This increases the diversity of users and their mutual complementarities. The following tables (Table 2 and 3) show examples of inappropriate and proper hotspots location.

TABLE II. EXAMPLES OF INAPPROPRIATE HOTSPOT LOCATION

LOCATION	JUSTIFICATION
Small green squares	• the place is completely subordinated to its one main function • lack of ability to carry out new activities, conflicts of different users' interests
Open spaces of railway stations and airports	• short term and spontaneous needs of the Internet usage independent from equipment, most frequently initiated and related to the desire of improving waiting time • users' concentration is distracted by many stimuli
Open spaces of stadiums, commercial buildings, etc.	• significant competitiveness by other activities • abundance of stimuli, a lot of traffic • the main objective of spending time is related to shopping or participation in events; using the Internet is an additional activity
Housing areas	• high density of buildings, disruption to flows of radio waves, difficulties of correct spatial arrangement • potentially small, an exclusive groups of users • possibility of misbehaviour in space after dark and conflicts in neighbourhood relations
Public squares and plazas	• the place is completely subordinated to its one main function • users' concentration is distracted by many stimuli

TABLE III. EXAMPLES OF PROPER LOCATION OF HOTSPOTS

LOCATION	JUSTIFICATION
University campuses	• high demand for the Internet usage • possibility of learning and collective work outdoor
Public parks	• enhancement of parks' offer • inviting new users • possibility of hotspot zones delimitation • lack of accidental users
Tourist resorts	• possibility of working out of the place of residence • facilities for foreign tourists staying longer in one resort

In conclusion, the hot spot suitable location should be characterised by:

- surrounding multifunctional space;
- good connection with the city;
- a sufficiently large space, where it will be possible to carry out various functions without mutual interference;
- the environment's good reputation; and
- remoteness from the main pedestrian transit routes.

Choosing a suitable location determines the popularity of the place and the proper use and diversifies usage, thus making the place attractive.

VI. DISCUSSION AND CONCLUSION

Public spaces in most Polish cities are not designed to meet ICT users' expectations related to quality of urban space. The idea of smart cities is becoming more frequently conceived by planners, authorities and the public at large. However, one can already find existing examples of first intelligent cities such as Masdar in Saudi Arabia and Songodo in South Korea. In parallel, a flood of technologies can also be observed. It begins to become apparent that a city filled with electronics is not authentic, it restricts and controls the behaviour of people [15]. One can observe an escape from technology by the lack of a television set, the lack of computer usage and, simultaneously, increasingly simply using mobile phones, etc. Many people do not have a TV at home, not for economic reasons, but due to an unwillingness to waste time. More often they meet at cafes and public spaces without access to Internet, which is considered as an asset. It is surprising that this generation of "digital native" better copes with balancing between life and new technologies than older users, who learned about the possibilities of the Internet at a later stage and are dependent on it [9].

It should be remembered that people have the right to choose. Open spaces should give the possibility both of being in places where it is possible to completely cut off from the technology, as well as allowing convenient use of the space. The aim of sustainable development should be wise and thoughtful implementation of new technology, but in a balanced manner, by creating specific spatial and temporal frameworks of those places that base on different principles and allow users to choose their preferred activity.

The argument, which appears to be the most rational and that goes against the furnished hotspots design is that the technology moves forward so quickly. The place of this type may be useless in a few years due to the fact that high-speed Internet will be directly available on any device adapted for this. This may happen but it is still far more convenient to use the Internet in a comfortable environment than on the run. Therefore, at the present time, it seems to be very necessary to create hotspots; their proper location and design having to meet the needs and expectations of potential users. This will not only extend the programme offered by public spaces, including green areas, but above all, it will attract new users, allowing individuals to relax in the open air, thereby affecting the

improvement of their health. Developing guidelines for hotspots location and formation is at this point necessary for raising the standard of these places, extend the benefits of usage by a growing number of users.

From a city's point of view the implementation of new technologies and financing of solutions are cost effective. The investment in innovation has a measurable value. The image of a modern city attracts ambitious residents, investors and tourists, which is synonymous with an increase in both direct and indirect income in the municipal budget.

Busy people need a stimulation to undertake the outdoor activity. The results of the research contain indications, which can be followed by designers. The future of the design is to respond to the needs of a modern society that is promoting attractive and competitive outdoor activities. The use of ICT fits perfectly into this leading trend, essential for human wellbeing.

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