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ENHANCING PLACES THROUGH TECHNOLOGY

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with a Foreword by Alessandro Aurigi

CONTENTS

FOREWORD

Space is not a platform – foregrounding place in smart urban design

Alessandro Aurigi

INTRODUCTION: AUGMENTING OR DENYING SPACE?

The Brazilian city of Curitiba, capital of the Southern state of Parana, is well-known globally for a series of interesting planning initiatives and choices promoted through its recent history by some of its administrators, amongst which probably the most prominent has been the architect-planner Jaime Lerner. One of the most notable pieces of innovation in the city, enjoying a global resonance, was the original design of the mass transport system known as Bus Rapid Transit (BRT). Thanks to various ideas, mainly related to the 'tube' design of the bus stops and the consequent affordance of a very fast exchange of alighting and boarding passengers, the operations of the BRT's long buses could be almost as efficient as that of an underground system. The story of the design and evolution of the BRT presents an interesting – albeit indirect – point of reflection for those involved in efforts of 'smartening up' the city through the application of technology. Lerner often tells the story of bus drivers solving through an extremely simple and low-tech idea – the application of two small marks on the bus's window and the stop's structure to allow drivers to always stop at exactly the same position – a problem that otherwise would have called for complex and expensive hi-tech solutions [1]. Similarly, when the BRT system was augmented with a new 'express' type of bus that would not call at all stops, allowing for quicker longer-haul transfers within the city, the issue of allowing such buses not to be blocked by slower vehicles stationing at facing stops in narrow roads arose. Again, this could have easily called for all sorts of smart, digital 'solutions', such as geo-locating the vehicles, sensing their presence and mutual position, maybe automatically controlling their speed through actuators in their engines linked with the centrally managed system. What was done, however, was rather smart indeed, yet involving no high technology. Simply, opposed stops were moved slightly, so that they would be staggered and allow enough space for the express buses to go through even when two slower vehicles were loading passengers at both sides of the road. This points at two key hints that matter in smart – in its wider sense – space design. One is of course the importance of simplicity. The other one, however, is the often underplayed – if not entirely forgotten in contemporary digitally-driven urban visions – importance of physical space and the role and agency it has in the city.

To state that 'the role and importance of physical space is not to be overlooked in smart city design' might sound terribly obvious and not worthy of discussion, but when it comes

to conceiving digitally augmented places, the proverbial danger of focusing on the finger pointing at the moon rather than admiring the moon itself can be a very real issue. In circles of smart city scholars and practitioners it is way too easy to concentrate on everything digital whilst overlooking or branding as outdated what we already know about the city. This way, we can end up associating change, solutions and agency to the former whilst looking at space as simply the recipient of technological innovation, or the stage where new technologically induced lifestyles will unfold.

The history of the intersection of urban space and digital technology shows how this has been driven by deterministic, tech-first (or even tech-only) perspectives in which cyberspace was the change factor making the difference, whilst people and physical space were at the receiving end of it. When the emergence of advanced telecommunications and virtual spaces were celebrated in the late 1980s and early 1990s debates were dominated by hyperbolic views of digital technology improving an otherwise decaying and disempowered world by making it more environmentally sustainable (see for instance [2]); boosting new forms of human association [3]; pointing at new ways of settling (or re-settling) in economically and socially viable small towns whilst cities became obsolete [4]; and generally affirming new, revolutionary economic and production models [5].

Linear, simplistic views of an all-dominating technology have been met of course with lively reflections and critique from various disciplinary perspectives. Yet, prevalent responses and continuous challenges to technological determinism have mainly engaged the socio-economic and political side of urban management and development, leaving physical space in the background. Social constructivist approaches, as well as those looking at public participation and lack of social inclusion and justice have looked at the social dimension of augmented place-making, yet often take for granted physical space as something already there, that did not need to be seen as a particularly active part of the equation. From early discourses of digital divides, inclusion and participation ([6], for instance) to more recent debates on smart citizenship ([7], [8]) and community participation, to yet further critique engaged with issues of socio-economic development, equality and justice ([9], [10], [11]), the role of physical space and its potential agency through design and ability to affect relationships could have deserved more attention. This absence – or quasi absence – is more pervasive than one could expect, with the physical aspects of place and spatial design being framed – from a variety of perspectives – as belonging to some fairly static – if not entirely problematic – background in the smart city narrative.

SPACE AS A GENERATOR OF PROBLEMS

First of all, the widely deterministic discourse coming from the corporate ICT sector [12] and smart city entrepreneurialism needs – in order to assert the urgent need for its proposed solutions and allegedly new urban models – to declare the current city as terminally ill. Smart city hype from a wide variety of actors tends to leverage on very much the same discourses of over-urbanisation, critical densities and the consequent pressures on urban

resources, the environment, citizen safety and management practices. Traditional ways of framing, understanding, managing and designing cities are branded as inadequate and fundamentally hopeless without the redeeming influence of high tech systems [13]. This is a revival and commercial leveraging of the utopian hyperbole of the start of the 1990s. The brand new world of cyberspace, seen twenty years ago as replacing many decaying aspects of urbanity, is now expected to save an equally critically malfunctioning city, and this is proposed through a series of very real hardware and software products and systems. In the perspective of mainstream smart city promotion, the various limits and issues related to physical space end up therefore being exaggerated and functional – hence looked at and highlighted – to the urgent digital innovation push. At the same time ways in which space could also matter, both in the sense of what it offers and of what it could contribute to change, are either entirely overlooked – as in the Cisco, IBM or PlanIT literature – or presented in an equally radical way, through the logic of producing brand new smart towns and settlements.

SPACE AS A FIELD OF ANALYSIS

A much more research-based and deeper-looking approach, yet somehow cognate to framings of the city as problematic and in need of brand new interpretative perspectives, is the growing – or somehow long-existing and now revitalised – field of studies related to spatial analysis and what has been defined as the 'new science of cities' ([14], [15]). Civic space and places constitute a field to be researched and analysed. Obviously, and in many ways, they have always been and rightly so. But the growing ability to harvest 'big' data through both civic installation of sensing hardware, and user/app-generated information about many measurable aspects of urban functioning – from environmental conditions, to vehicular and pedestrian movement and people's behaviour in public spaces, has opened up new and exciting horizons for spatial analysis. What used to be fairly static analytical tools based on Census-fed GIS systems can now develop into real-time, rich and sophisticated instruments. Whilst there is nothing wrong with this *per se* – in fact we need to be able to triangulate as much evidence as possible to reach a better understanding of the dynamic urban environment – the city, and above all its physical places and their design, act here as an information provider and a field to be studied. On the one hand difficulties remain in actually effectively triangulating very different forms of evidence. What happens to phenomena and aspects of the city that are not easily measurable, for instance? On the other hand, physical space is interesting as the object of analysis, but much less engaged in terms of its design and ability to change things. And indeed many aspects of actual space design are not as easily coded into such 'spatial' analysis, where human movement and behaviour (so, social aspects of urbanity) and their environmental consequences have the lion's share of the attention.

SPACE AS STAGE OR PLATFORM

Much work – both in terms of critique and practice – has gone into considering how the development of digitally-enhanced places and of situated interactivity could be re-framed in ways that would make it more locally engaged, participatory or based on provocative and alternative concepts to mainstream e-governmental, city management and place-marketing approaches.

This work ranges widely. One aspect is the reflection on the non-neutral, contested nature of urban analysis systems and dashboards [16] and the critical analysis and facilitation of various forms of grassroots or public-private action involving the production of locally relevant smart initiatives and the networking of these [17]. Another is the conception of non-profit systems and digital situated urban gaming (like the work and studies by the Hackable City project in The Netherlands[1]) and art installations, open to the general public and providing a much-needed public space-based, inclusive, interactive and critical dimension to city smartness. Much of the work carried out within the Cyberparks [18] EU-based network is of such a nature, as a variety of initiatives of public interaction design across the globe. Other notable examples include the work of the Media Architecture Institute [19] as well as international networks and festivals fostering and showcasing interactive installations, such as Bristol-based Playable City [20].

It can be argued, however, that even in these more socially committed cases, there remain two dangers. One is the danger of self-referentiality, as the makers and their colleagues may also tend to be the main users and commentators, obviously reinforcing a circular logic in confirming the validity of the projects. De Lange's set of interviews with Playable City actors in Bristol (2015) highlights the positive shifts from a tech-centric to a people-centric view of the smart city, but also seems to reveal a degree of self-containment, where a relatively close and specialised artist community appears to measure the value and impact of installations through the personal/participant reactions of its own members. The other danger is a prevalent focus on the project *per se*, and on its technical or social character, rather than on the initiative as being conceived, analysed and strictly evaluated as part of any wider place-making strategy. Much of such practice of digitally augmenting place is dominated by projects that are temporary and/or mobile installations or applications, conceived to be transferred to or replicated in very different locations. This can be a limit to their active participation in, and design consideration of local context factors, and can lead to often omitting to look into what is left, or permanently affected in the place, once the project ends.

To take just one example of a relatively early – yet still very relevant – digital augmentation project of a public space, particularly relevant in the context of the shaping of 'cyberparks', we can look at the Sonic Arboretum in Montreal. This project, conceived in the mid 2000s, aimed at augmenting the character and functions of a public small park – the Emile

[1] http://thehackablecity.nl/

Gamelin square in Montreal. A parallel digital environment, accessible both remotely and within the physical square itself, augmented the park's physical features – trees and other structures – with digital exchange and interpersonal communication functionalities, with a focus on music files sharing. Whether the project would indeed manage to interestingly articulate the digital and the physical in potentially synergic re-combinations (the virtual, exchange trees were conceived to match the real ones in the park), the focus and design effort was described as a:

" [...] strategy of situating mobile communication activity within the larger framework of urban spaces as ecosystems, in which wireless networks would be more "holistically" incorporated into the environment. This approach allows us to contextualize the flow of information within an expansive stream of other interactions: the flow of people, traffic, food, resources, energy, weather, and ideas." [20]

It can be argued that physical space was therefore still subordinate and playing a background, supporting role. The project's central aim was not to understand, reconceive and re-design the park as a whole, but more about using the park as a rich platform for digital interaction. The same initiative could have been exported and replicated in any other place featuring open space, pathways and trees.

Similarly, the already mentioned and well-known Playable City initiative and network, an idea originated in Bristol with increasing global extensions, aims to put 'people and play at the heart of the future city, re-using city infrastructure and re-appropriating smart city technologies to create connections – person to person, person to city' [21]. This is an interesting and attractive statement, putting an emphasis on some important, social aspects of place-making, yet fundamentally treating physical space as the 'city infrastructure' that can act as a platform or stage for the interactive play-facilitating connections. Playable City installations can certainly be provocative, evocative and useful to encourage interaction and increase the range and frequency of use of specific public spaces, but it is debatable whether they really start from place, have a close dialogue with it and aim at exploiting the possibilities offered by designing it holistically.

TOWARDS A HOLISTIC VIEW OF AUGMENTED PLACE

The distinct examples briefly discussed so far reflect a range of differing views. For instance, the located interaction and urban gaming movement strongly stands in its vision and aims against the top-down, corporate logic of much of the industry-driven smart city set of solutions. The issue in all of them though tends to be that physical space ends up at the supporting and the receiving end of urban change, but does not seem to actively participate in it, or even inform it. In this sense, they are all somehow deterministic towards space. This is impacted upon, saved (or remedied), enriched or it simply provides information that can be analysed. Whilst the more participative digital interventions aim to complement the technology dimension of 'smart' with the social/people layer as rightly

essential to place-making, much less attention is given to taken-for-granted urban space as a third, essential aspect of the smart city.

The importance of looking at digital technology as part of a multi-layered urban 'whole', and the need to imagine and design this whole as one, has of course has been discussed before. Following William Mitchell's intriguing concept of 'recombinant architecture' [22] and trying to expand that perspective with a more operational framework, Thomas Horan stressed the need to look at a whole place design perspective, rather than at digital add-on 'solutions'.

'At one end of the digital place continuum are "unplugged" designs that manifest little or no digital technology in their appearance and construction. Toward the middle of the continuum are various "adaptive" designs, representing modest attempts to visibly incorporate electronic features into physical spaces. Occupying the far end of the spectrum are "transformative" designs: rooms, buildings, or communities composed of truly interfaced physical and electronic spaces' [23].

Horan's language could still be accused of being affected by a residual dualism – as he talks of physical and electronic spaces as potentially separate layers to be combined. But pervasive computing and the so-called *Internet of Things* were very much in their infancy then, and so were spaces and objects that could be seen at the same time as both physical and digital. The concept of 'transformative design' was nevertheless powerful in pointing at the fact that physical space, digital technology, and people (who live re-combined physical/digital lifestyles) need to come together.

And when projects accept the complex challenges that come from exploring extended, re-imagined ways of using public space and defining useful everyday typologies, rather than being add-on digital art or interaction, physical space becomes part of the equation again. An interesting experience and commentary came from the Breakout project aiming at bringing knowledge work into public spaces [24] . The research team observed how issues of digital living (and more specifically, *working* in this case) actually combined with those of physical space organisation and design, and greatly depended on contextual factors. The project did not just stick to a deterministic view of high technology impacting and changing the otherwise static platform of space. Instead, space actively participated in the equation, affected the 'digital', and ultimately the two could not be de-coupled in trying to fulfil the design programme. Once physical space is taken into account and engaged with, with a perspective on inhabitation and (relative) persistence rather than a simply performative 'installation' mode, this calls for proper design considerations such as looking at private/public thresholds; how different activities help or hamper each other; presence of shelter and seating; filtering with building space and so on. All of a sudden, the physical component of place becomes again a very active actor/participant, and sometimes a rather difficult one to deal with, rather than an allegedly docile and passive 'host'. In other words, and however obvious this might sound, if we intend to design augmented places, we would be better off interrogating and articulating all aspects of 'place' and their relationships and affordances, in a holistic way.

APPROACHES TO DESIGNING AUGMENTED PLACES

What can this mean in practice? How can the process of designing augmented places be enriched? This paper has argued so far that, whilst attention is being placed on the need for more bottom-up social participation in the shaping of smart landscapes, much less thought has been invested into re-introducing urban and architectural design principles and knowledge in order to let physical space – and actions involving it – participate directly.

At the start of the 1990s, in an article on remote communication entitled *Being There*, David Brittan mentioned a conversation with Chris Turner, from Olivetti Research Laboratories in Cambridge:

Do you need to see a video image of someone just to be asked out for a beer? "Well, you don't - Turner admits - but don't you think it's rather criminal that you can't?" In his view, the advent of two-way video on computer workstations is a matter of manifest destiny [25].

This we need to move away from: the attitude of deploying technological 'answers' just because we can, or we want to, where there are no clear or well-justified place-based questions after all.

A good starting point therefore is to move away from a solution – and product – based approach, back to an increased awareness of place and the principles and dimensions that can inform its functioning, perception and ultimate shaping.

ASKING PLACE QUESTIONS

Place is complex, and that complex overlapping of aspects, issues and opportunities – if an effort to grasp and understand them is made – can provide important clues towards its improvement by design. Carmona et al [26] for instance identify six interrelated dimensions of our cities as morphological, perceptual, social, visual, functional and temporal layers. Regardless of whether one embraces such a framework, or a slightly different one, a major mistake here would be to think that digital technology constitutes another, discrete new add-on layer. It does not. Instead, it combines in rather intricate ways within the existing dimensions adding more complexity to them. ICT interacts with the form and perception of the city, its social life and milieu, and so on, participating in a process of constant redefinition of relationships. To understand how ICT impacts these dimensions, and how to use it within specific places, we need to 'question' those urban layers.

An example of this line of thought has been discussed by Aurigi [27] when noticing that the otherwise advanced system of public and interactive terminals in the Finnish city of Oulu was deployed as an 'ubiquitous' solution. Questions about usability, information potential, or functionality had been raised – together of course with addressing a plethora of technical issues – yet questions about the specific spaces and places involved, with their character and 'wisdom' had been overlooked. It was noted how "The terminal/hotspot placed in the market square [...] could really play a significant – and significantly unique

– role in a symbiotic relation with the specific place it is part of. As a market square is eminently a space for exchange and transaction (social as well as financial), this character could be boosted digitally by providing place-based opportunities for digital exchange. The possibilities within such an 'augmented market' perspective would still be many and diverse, but they would focus on reinforcing and supporting the place's culture, uniqueness and strengths, rather than providing a 'ubiquitous' service. Context would not just be an opportunity, but it would become one of the central generators of the digital intervention".

Anybody who has ever participated in a design review – be it academic or professional – for an urban or architectural scheme, knows the crucial role that a series of place-probing queries play, towards the formulation of an effective brief and set of design intentions. What relationships (spatial, social and economic) exist there and make the place what it is? What meanings does it have for people? What form(s) does it have and how can it be perceived? How is it used, how do people and things move in it, and what happens there? Who lives there or uses it, and why, and what do they think and feel? How does time affect it? How do environmental conditions affect it? And, more proactively, designers might need to reflect on questions like: is there anything about the place that we need or want to either accept or contrast with, through attitudes ranging "from submission, through symbiosis, to domination" [28]? What potential – as well as conflicts and contestations – does the context have? Can this space play a role in a wider urban strategy? How does it exist and function within a larger place (the neighbourhood, the city, the region...)? These questions, and more, are essential if one is to start exploring how a new urban element – physical, digital or indeed hybrid – could alter the system of relationships already characterising a certain place. They allow us to discover what – if anything – might be needed at all. Yet, these questions are seldom asked before a 'situated' digital project is conceived. Whilst the interface and interaction with 'users' or some of the conceptual aspects of the design are often thoroughly looked at, to echo Horan's early concerns, the deep 'transformational' interfacing with place is easily overlooked.

EXTENDING THE PLACE-MAKING DESIGN TOOLBOX

On the one hand interrogating and understanding place – hence bringing 'space' as a crucial component of it fully back into the picture – can be the first step towards a more sophisticated approach in the design of smart environments. The next challenge however is developing an insight into how the 'digital' participates and integrates with the spatial – in a circular relationship rather than a one-way impact trajectory – in making, or re-making place. In other words, once analysis and intentions are clearer and richer, when it comes to actually designing in a hybrid way, how well are we aware of the possibilities (and threats, potentially) of the extended toolbox we are going to use?

Transformative design calls for seeing high technology not as a self-contained field, but as a set of available additional 'materials' and possibilities, integrating with, expanding and sometimes problematizing the already complex place-making toolbox. Beyond utilizing ICTs for their capacity to extend social networks and public participation through cyberspace,

their potential also needs to be understood within a wider (urban) design perspective, as they can extend and make more fluid a series of very local spatial relationships, perceptions and behaviours.

So, for instance deploying systems that allow communication between remote places or times is not just an exercise in expanding human possibilities, networking and ability to participate, but also an act of altering spatial perceptions by problematizing the 'here' and 'there', and the 'now', never in a neutral way. As many people may experience a loss of privacy and sense of 'refuge' in their homes and bedrooms thanks to always-connected mobile devices [29], ICTs are part of our space, and how those deployed in public places are shaped and used must be part of a conscious act of spatial strategy and design.

When we design spaces we are encouraged to consider the consequences on publicness or privateness and intimacy – and often public-private 'filter' conditions and 'third places' – of the different parts of the environment we are shaping. Yet, when we design augmented spaces, such relationships are still there but complexified and challenged. What was intimate can be made more public through digital means, whilst people can have more opportunities for electronically-facilitated intimacy (and detachment) in very public areas. Similarly, accessibility – both physical and psychological – to places and their characteristics can be re-defined. Relatively invisible or impermeable areas can benefit from a degree of digital visibility and access. The availability and public awareness of various characteristics of place – its history for instance – can be differential, depending on how this is expressed: through physical public signage or inscriptions, pay-per-view exhibitions and information, or electronic layers available only to those who can access them and know how to do it.

Place has always embedded different meanings for different people, and the electronic multi-layering of located information and interaction can further enhance this. However, it can also risk saturation and loss of meaning (too much going on could simply undermine character and purpose of space), or create some kind of interpretative dissonance: whilst the space suggests certain uses and meanings, the digital layer could afford radically different and antithetic ones, as Pawley noted in his discussion on 'stealth architecture' [30]. Whilst this is not necessarily negative – provocation and alternative affordances can be important design moves sometimes – it is crucial that designers of augmented spaces are aware of what they are doing. We can let people hunt for Pokémons anywhere, including for example in a religious building or a cemetery, but do we really want to, and why? What does it mean for that place, for how and why it was designed, and for its character, cultural and practical functioning, and its *raison d'etre*?

CONCLUSIONS

This paper focuses on a gap in research and practice, as the importance and role of physical space and urban design have been looked at only marginally within smart city debates and it suggests – only tentatively – a way forward, by highlighting the need for enriching the two phases of brief-making for, and designing, digitally-augmented places.

In order to formulate an effective brief for improving a public space – or indeed any other environment – regardless of the instruments and technologies used to do this, it is necessary to read, analyse and understand the place and its complexity, so effective intentions can be formulated. Plugging in a project/installation as a simplistic add-on to an allegedly static and passive spatial background is likely to seriously limit its place-making potential. Yet, current discourses and practice tend to facilitate just such approaches, and it would be interesting to conceive and pilot more thorough urban design-based evaluations of 'located' initiatives.

Once a rich and place-based brief has been conceived, the issue of updating our design knowledge to reflect the augmented possibilities also arises. On a speculative and intuitive basis it seems clear that issues of spatial relationships and agency, scale, access and mobility, inhabitation, meaning, perception and memory – and more – which we are accustomed to consider carefully when shaping public spaces, are still important yet often ignored in smart city thinking. On the one hand they should not be jettisoned in the name of an alleged brand-new logic of place dependent solely on the redeeming and innovating power of ICTs. On the other hand they do need to be updated and upgraded to inform design in a re-combined world. It is debatable whether this can be achieved simply through repeated and evolving practice. This upgrading probably needs a thorough research effort. In the 20th Century much intellectual energy had gone into trying to understand articulations, languages and syntaxes of space, and how designers could harness such principles. From Cullen [31] and Lynch [32], to Norberg-Schulz [33] or Hillier [34] – just to name a few – ideas on how space, people and things articulate were usefully framed to help designers make sense of the complexity of places, and to help them become more aware of the potential consequences of their own moves. It could be important now to refresh those efforts and frameworks in the light of the emergence of new variables and extended relationships and possibilities.

Should we therefore augment not just spaces, but our questions about 'place', and design thinking too? In those questions, and an increased awareness and mastering of a series of extended principles for understanding how hybrid space works, lies the quantum leap between just designing self-contained interactions, which at best are 'located' somewhere, and effectively shaping augmented place, making a significant difference for our cities.

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INTRODUCTION

Enhancing Places through Technology

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The rapid diffusion and uptake of Information Communication Technologies (ICTs) presents a new and unique challenge for cities as social life and urban space becomes increasingly (yet unevenly) mediated by new technologies and digital devices. As ICTs continue to infiltrate urban and social realms, there is a pressing need to understand the complexity of this rapidly expanding social and spatial phenomenon. The papers in this collection contribute to an emerging body of work that seeks to understand the relationships between people, the physical urban space and opportunities for place-making, and technology. These three dimensions form the vertices of an important triangle, having far-reaching implications, be it in the development of new technologies, in the understanding of human behaviour and in the definition, and possibly rethinking, of urban spaces. Possibly more importantly, there are significant overlaps, and interfaces, between these three pillars that are investigated by some of these papers.

The proliferation of, and accessibility to, new technologies have raised significant questions to both research and practice. Technology has redefined our lifestyles on a day-to-day basis and our relationships with one another. It has challenged our conventional outlook towards time and distance and required us to re-evaluate our connection with physical space. It has also made us re-question the value of urban space and the extent to which we may still create meaningful 'places' as opposed to anonymous 'spaces' – an increasingly challenging concept given the risk of alienation brought about by technology and that constitutes an unfortunate, but very real, prospect.

The papers present interdisciplinary perspectives from architects, computer scientists, sociologists, urban planners and designers, among others. Diverse approaches to the research field are also offered, including work on new methodologies, new theoretical or conceptual models for the digital era, as well as preliminary studies of peoples' use of, and engagement with, technology in public space. At the heart of these discussions lies the term 'enhancement', understood in terms of the added value that ICT may bring about, contributing to broader quality of life objectives.

The collection of papers in this publication formed part of the *ICiTy: Enhancing places through technology* conference that took place at the University of Malta, 18-19 April 2016. The conference was a mid-term research event for the EU COST Action TU1306 (CyberParks). The play on words suggested by the name of this conference tried to portray the blurriness between 'ICT' and the 'city' (as a representation of the urban realm) that

is being faced today, suggesting the pressing need for it to constitute a research focus in its own right. As such, many of the papers in this collection present works-in-progress and report on the preliminary analyses of data. The book of conference proceedings has three parts.

PART I: DIGITAL METHODS AND SOCIAL PRACTICES IN PUBLIC SPACE

Papers in this section deal with recent and novel ICT-tools that have been (or are being) developed in order to research the use of, and user-behaviour within, public spaces.

The paper by Bahillo, Díez, Marušić, and Marušic reports on a pilot project conducted in a shopping mall in Spain, for which a cooperative location network was developed to assist carers in monitoring the position of their dependents, as the latter roam freely in the space. The authors discuss their implementation (in which dependents are outfitted with a Bluetooth low-energy bracelet), and anticipate how aggregated data from the use of such tools could also serve to gain behavioural mapping insights.

In their paper, Duarte and Mateus report on the initial testing of the WAY Cyberparks application, tested in a Lisbon park in June 2014. Park visitors who download this app have their route tracked, and are prompted for location-based feedback about their park experience as they explore the space. Despite some technical challenges, the early iteration of the tool was assessed as easy to use, as the authors express optimism of the tool's potential future effectiveness at guiding the improvement of public spaces.

The paper by Pierdicca et al explores the topic of mobile AR applications for tourism, outlining best practices as well as technical limitations of such applications. These considerations informed the development of an AR module to be integrated into the WAY Cyberparks app. The authors describe the implemention and testing of this app in Valletta, and report encouraging results for the potential of AR as format for future outdoor touristic and learning experiences.

Complementing the previous paper, the paper by Bonnano et al presents a connectivist approach to the design and evaluation of learning in technology-enhanced open spaces. An inventory of relevant theoretical models is provided, highlighting various dimensions applicable to any Smart City Learning intervention, and identifying various types of learning possible within this context. The connectivist model is applied toward the design of two mobile learning activities designed for sites in Valletta, and managed through the WAY-Cyberparks app.

The paper by Artopoulos presents innovative experimental work in which a variety of immersive technologies are employed to create a virtual reality (VR) environment through which to explore a complex historical site in Nicosia, Cyprus. This system allows users to explore the site while navigating through spaces, historical periods, and roles. Ultimately, the aim is to invite diverse users to explore and ultimately co-curate the architectural

intervention of a complex historical setting. In contrast with the typical practice of presenting historical settings as static spaces weighted with a baggage of historical content, the author convincingly argues that historical settings can potentially serve as a stage upon which visitors can actively express and explore layers of memory and meaning. As such, sensitive and skillful historical interventions can advance the value of social sustainability while also re-associating with the everyday life of the public space.

As mobile phone use continues to intensify, the paper by Joković, Dimitrijević, Atanasković, and Dončov offers a comprehensive introduction into the issue ofelectromagnetic frequencies (EMF), which can potentially impact human health. Basic concepts concerning electromagnetic radiation are introduced, and two prevalent sources are identified: cellphone base stations, and mobile phones themselves. Standard measurementand estimation techniques are described, as well and the variable factors that add complexity to the measurement task. The paper mentions how EMF levels are systematically measured in all European countries from time to time, and reports that the measured radiation levels are currently well below the recommended exposure limits. Notwithstanding, this issue (of EMF exposure from fixed outdoor sources) has importance in the long-term risk assessment of populations in public space.

PART II: ETHNOGRAPHIC CHALLENGES AND THE CREATION OF DIGITALLY MEDIATED URBAN SPACES

Papers in this section explore contemporary design research and innovative open space development practices, illustrating the design challenges of new media for urban and landscape design, and discuss cultural and sociological fieldwork using innovative theoretical and methodological approaches, addressing contemporary knowledge about the use of new media technologies in public spaces from an ethnographic viewpoint. The papers thus address three broad themes: research methodology; applied work; and design challenges.

The first paper by Suchocka, Maksymiuk, Kimic and Kołodyńska is an empircally informed paper that explores the main types of Wi-Fi users in urban spaces and their main activities. They focus specifically on the group they call the 'digital natives' – those who are comfortable and familiar with technology and ICTs. Four types of ICT users were identified within this group: those focussed on work; those focussed on entertainment or social engagements; those passing through as pedestrians; and tourists or other such users. Through observations, interviews and an online questionnaire, this study reveals robust empirical insights into the behaviours of ICT users. Importantly, the study found that users of Wi-Fi hotspots are diverse and they approach the space for different reasons. The research will inform designers and design guidelines for urban public spaces with technology.

The role of ICTs in enhancing citizen engagement in decision-making is the focus of the paper by Ivanova-Radovanova and Radovanov. Here, the authors describe a range of initiatives currently being deployed in the city of Amsterdam, The Netherlands. The authors draw on

research carried out with residents in the city of Sofia, Bulgaria, to gauge the reactions of citizens to the Amsterdam examples. The particular aim of this research is to explore whether initiatives may be transferable between differing urban contexts, and what role the specificities of urban context play in the success and/or failure of such initiatives.

The paper by Bull, Everitt and Rieser describes the *Greenview* project which involved the development of an APP for the purpose of creating behaviour change among users, specifically in relation to energy consumption on the university campus. For this project, animated cartoon characters were created to act as virtual mascots in each university building. The APP was developed to elicit an emotive response from users (based on the emotive nature of the 'Tamagochi' concept) as an engaging way of encouraging them to care for the environment. The central premise of the APP is that when energy consumption levels exceeded those on the same day of the previous year, the visible well-being of species would change, thus highlighting to users the increased energy consumption and drawing out an emotional response, with the aim of encouraging a change in behaviour. The authors pilot tested the APP with a sample of participants to determine key strengths and limitations. In all, the team found that the Greenview APP was perceived by users to be friendly, fun and visually attractive. Participants recommended that the APP needed to be more intuitive and interactive, and also incorporate guidance for users to help them behave differently with regard to energy use.

Suchocka, Maksymiuk, Kimic and Kołodyńska present a second paper based on an initial premise that technology and landscape architecture may interact seamlessly, thereby increasing the potential value of public spaces and users' experiences therein. Building on a previous research carried out by the same authors, which assessed users' behaviour and expectations of technology within leisure spaces, and supplementing this with further empirical work, the authors identify salient spatial characteristics that would incentivise users within public spaces and subsequently suggest tangible design and development principles for hotspots, discussed from specific points of view including users, disadvantages of mobile devices' usage, weather conditions, equipment, materials and health condition (comfort and broader quality of life considerations). Following on from this discussion, the authors proceed to provide some examples of proper and of inappropriate hotspot locations. These principles and examples offer useful pointers that could inform both further research and practice, understood in terms of design policy formulation and implementation. The authors make some final observations regarding the attitude of the new generation of 'digital natives' towards technology and conclude that, while the development of appropriate hotspots is an important requirement, one should not forget the rapid rate at which this technology is changing. They reiterate the crucial role played by open spaces in attracting new users, in providing a setting for the interaction with technology to occur and in contributing more broadly to individuals' quality of life, which should remain central to the discussion.

The paper by Menezes and Smaniotto Costa offers a review of the methodologies and questions associated with ethnographic research, and argues that despite the emergence of new data collection methods, the urban ethnographic toolkit remains a valuable research methodology, because it allows for detailed, culturally-sensitive data collection, with a human-centred perspective. As such, the authors propose an analytical ethnographic framework designed to guide further discussion within the CyberParks project. The framework analyses two rich intersections: firstly, the intersection between information communication technologies (ICT) and urban public spaces (UPS); and secondly, the intersection between ICT and processes of planning and citizen participation. The framework offers a set of 7 questions to guide inquiry, and highlights several dimensions of analysis.

The paper by Botteldooren presents a succinct analysis of principles of classical soundscape design, and discusses how ICT might be used in soundscape design of urban public spaces. To introduce urban soundscape composition, the author distinguishes between the categories of 'backgrounded' soundscape, supportive soundscape, and focused soundscape. Whereas consideration of urban sound has often been confined to a question of noise control, the author cites the potential restorative effects that sound can have, and offers innovative examples of interventions in which sound design influences mood and behaviour in urban public space. Finally, the author describes how the evolution of machine listening opens new possibilities for dynamic urban soundscape design. He anticipates an "internet of sound observatories" combined with different types of actuators and interfaces, which could dynamically alter sound elements or the manner in which they are perceived.

PART III: REFLECTING ON THE RELATIONSHIPS BETWEEN PEOPLE, SPACES AND TECHNOLOGY

Papers in relation to this track reflect on philosophical and methodological approaches and illustrate evidence-informed practice that seeks to understand the complex relationships between humans, public spaces and new media development and how it is (or should be) reflected in the urban fabric and place design.

Social media practices and activities, specifically tweeting in public spaces, forms the core focus of the paper by Djukic, Vukmirovic, Jokovic and Dinkic. The authors aimed to explore the connections between users of online social networks and their engagements with urban public spaces, with a specific focus of Twitter. The study reported on in the paper analyses data gathered from several public spaces in the city of Belgrade to highlight the types of public spaces most attractive to Twitter users in the city, by analysing the concentration of users in public spaces. The results allowed the authors to determine the image of the open public spaces perceived by the users, as well as the intensity of users and tweets through the social networks, with the aim to measure the quality of open public spaces and concentration of users.

The paper by Breser, Zedlacher and Winkler draws on a recent project from the University of Graz, Austria, that explored some technical solutions for representing archival sources of information for urban areas in the digital era. Particular challenges for creating digital archives that are explored in the paper are those related to the archive practices of the analogue world. Here, the authors identify problems with the means of classification of the archives, assignments, semiotic systems and descriptions. In the paper, the authors make use of software applications and mobile technologies to offer solutions for overcoming such problems. The overall argument is that there are very real challenges in comparing and transferring analogue methods to the digital world which are essentially related to the modes of practice in digital and analogue archives that are incompatible and this needs to be reviewed and addressed so information and research materials related to urban areas may continue to be archived into the future.

Klichowski and Patricio present recent work from cognitive neuroscience to explore the question of whether the brain really likes ICT tools and being outdoors while using these tools. The aim of the paper is to evaluate concepts that promote technologically-enhanced outdoor activities, such as CyberParks. The paper poses three main questions: Does the human brain really like ICT tools? Does the human brain really like being outdoors? And finally: does the human brain really like technologically-enhanced outdoor activities? The results of the studies presented show that the human brain does not like ICT tools yet; it likes being outdoors very much. At the same time, it was shown that outdoor activities may be encouraged by ICT tools, yet outdoor activities themselves should be free from ICT tools. The paper concludes that, from the perspective of cognitive neuroscience, CyberParks are not a solution that the human brain really likes.

In a similar vein, the paper by Lister evaluates the concept of smart city learning. In the paper, the author draws on data from an examination of learning experiences in two public spaces in the city of Valletta, Malta. It is argued that the measurement and analysis of individually interpreted learning experiences may build a knowledge picture of how learners perceive immersive technology-mediated learning in smart cities. Mobile learning location--based prototypes were developed and implemented in the two public spaces. The author discusses potential methodologies for designing a measurement of the effectiveness of these learning experiences and associated learning design for immersive urban learning environments mediated by mobile and networked technologies. The research aims to contribute to current approaches of urban smart city environment planning for citizen-engaged 'human smart cities'.

The timely research theme of co-creation in urban planning forms the focus of the paper by Mačiulienė and Mačiulis. In this paper, the authors argue that the notion of cocreation may be used in urban planning by treating citizens as active, creative, decisionmaking equals rather than as passive recipients of top-down design. The focus of this article is the creation of a typology of citizen engagement strategies in urban planning, which shedslight on broader issues around the relationship between technology, urban development and

public participation. By exploring and critically assessing case studies of citizen co-creation in the city context, the authors attempt to illustrate how citizen engagement may lead to construction and redefinition of public spaces.

The paper by Patricio represents a unique offering in this collection with its focus on theoretical and philosophical questions about technology. The work draws on the writings of Nietzsche and focusses on the notions of geophilosophy and geoaesthetics. Patricio's paper is an attempt to read the notion of CyberParks through a Nietzschean perspective and regards the implementation of land art and site-specific art projects as further developments of a CyberPark.

Finally, the paper by Vassi and Vlastos examines the interactions between information technologies and urban public spaces, focussing specifically on the road as a key public space. They argue that technology has altered the nature of the road within cities, as well as the nature of urban transportation. While roads traditionally accommodated vehicle traffic, as well as some leisure, social and work activities, the authors argue that technology has enabled private activities to enter into this more traditionally public space, hence blurring the boundaries between public and private. They focus in particular on the ways in which technology has diversified the means of transport available including the advent of car-sharing schemes and bike rental facilities within cities. Overall they argue that technology is reshaping urban transportation and at the same time it is redefining the road.

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PART I
DIGITAL METHODS AND SOCIAL PRACTICES IN PUBLIC SPACE

A Dependents' Cooperative Location Network for Behaviour Analysis in public spaces

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Damjan Marušić

Abstract – *Many dependents such as children, elderly or disabled people get lost or missing, but as dependents, they often lack the skills to protect themselves, and carers cannot keep their dependents in sight all of the time. Therefore, the challenge to be tackled in this paper is to develop a dependents' cooperative location network over which carers could monitor the dependents' positions in real time, giving them more freedom to safely roam within public spaces. Not only in open spaces such as crowded parks or streets, but also inside buildings such as city malls, museums or nursing homes. The aim of this paper is twofold, to create a cooperative and dynamic network of carers over which to monitor the position of their dependents by means of standardised technologies, and to understand how the physical environment could influence dependents' activities by means of behavioural analysis in public spaces.*

Keywords - Cooperative location networks; behaviour analysis; mapping; safety; security.

I. INTRODUCTION

Improving citizens' mobility in terms of their safety and security is one of the major concerns of cities all over the world. Half of the world population is concentrated in cities and by 2050 two thirds of world's people are expected to live in cities. This trend will increase the challenge. Many citizens get lost or missing in cities, especially the children, our Nation's most precious resource, but as children, they often lack the skills to protect themselves. According to the Study on missing children from the European Commission [1] in the European Union: on average, 400 out of every 100,000 children were reported missing within the period 2008-2012 in the EU. Not only the children, but the elderly and disabled people (dependents in general) are the focus of this work. Knowing the dependents' location is the key to knowing that they are safe. However, carers cannot keep their dependents in their sights all of the time. Therefore, the challenge to be tackled in this work is to develop a cloud service over which carers could monitor the dependents' positions in real time, giving them more freedom to safely roam within the public spaces. Not only in open spaces such as crowded parks or streets, but also inside buildings such as city malls, museums or nursing homes. This way, apart from calming the carers down, they would not need to use their cars to move the dependents thus reducing the CO2 emissions, traffic jams, stress and time.

Currently, the market offers four kinds of solutions for positioning the dependent. The first one uses a hose-clip or a wrist-band that integrates a GNSS (Global Navigation Satellite Service) receiver to determine the geolocation of the dependent, and a modem to send the geolocation data to the carers via cellular networks. However, it has a high cost, around 100 €, it needs an extra monthly fee due to the cellular data communication, and it does not work indoors ([2], [3], [4], [5]). The second one tracks the smartphone of the dependent using their sensors. However, it can only be used for those that routinely carry a smartphone, uncommon for the dependents' profile, and its availability indoors is limited [(6] and [7]). The third one uses a low-cost and battery free NFC (Near Field Communication) bracelet, such as the passive RFID (Radio Frequency Identification) technology, that is carried by the dependent and whose position is updated every time the dependent's bracelet is detected by a NFC reader. However, its range is limited to a few centimetres which means that a big amount of NFC readers would be needed to track the dependents [8]. The last one is technology free and thus the cheapest one. It uses a bracelet where the main profile characteristics of the dependent have been written down. However, it cannot track the dependent and the bracelet has to be identified visually [9].

The solution proposed in this work uses a bracelet carried by the dependent. It integrates a low-cost BLE (Bluetooth Low Energy) transceiver which regularly broadcasts a unique identifier (ID) at constant power. Its range depends on the transmission power, but it usually ranges from 20 to 50 metres. The dependent bracelet's position is determined within the range of a carer BLE transceiver, while the position of the carer is assumed to be previously known – if its BLE device is fixed – or estimated by a location engine [10] – if its BLE device is dynamic. Section II describes in more detail the system architecture of the solution and how it tracks the dependent. The city of Valladolid (Spain), involved in the *VyP* smart city initiative [11], has been selected as the test location for the proposed solution. Its city council is highly concerned about the importance of guaranteeing safety and security for their citizens, enhancing the mobility of the dependents in public spaces. Vallsur, which is the largest mall in the city of Valladolid, showed its interest providing its facilities for testing the solution. Section III describes the experimental setup.

Theoretical backgrounds supporting contemporary research addressing activity behaviours and design of public spaces are mostly grounded in environmental psychology, e.g. affordances [12], and behaviour settings [13], but were gradually adopted for the focused purposes of planning or design [14]. Another relevant concept for environmental planning and place design related to user-spatial relationship, referring particularly to spatial problem-solving, is wayfinding. It is cognitively and behaviourally concerned and according to authors encompasses four discrete stages: orientation, route decision, route monitoring, and destination recognition. In planning and design disciplines such inputs are crucial in analysis and design of spatial sequences and their relations into complex territories.

Behaviour setting is defined with the relationship of social and environmental characteristics of places and refers to a standing pattern of behaviour which is tied to a particular place and time [13]. In practice this means that certain types of place, including socio-cultural contexts, elicit certain types of behaviour that are most probably expected and/or predicted. Behaviour maps, records of behaviour patterns in places and a tool for usage-spatial relationships analytics and evaluations [15], are strongly linked with behaviour settings. In a very literal sense behavioural mapping is really the footprint of a behaviour setting or settings. Behaviour settings offer a useful unit of analysis of how aspects of environmental design are related to people's activities in places, and hence, behaviour mapping represents a method and tool for visualising and monitoring usage-spatial relations and can act towards guidance for socially sustainable design.

Behaviour mapping approach is useful if sufficient repeated observation in a place is done. The major value of behaviour maps as a research tool, lies in the possibility of developing general principles regarding the use of space that apply in a variety of settings. Overlapping individual behaviour maps can show some characteristics and changes in using spaces in terms of activities, number of people engaged, gender, and all the other variables that were explored. Thus there is a challenge to set up and promote a monitoring digital tool which can as much as possible unobtrusively function for users' engagement with places as well as the device/tool itself. In the context of shopping areas research for spatial analysis way finding approach and analytic behaviour mapping are seen as challenging to address issues of usage-spatial relationships.

The target users who will benefit from this solution are the dependents living in a medium or large city where security and mobility issues are evident; and the carers who will monitor for their safety. The customers will be the public administrations and nursing homes who are interested in giving the dependent more freedom to safely roam within the public spaces, reducing the costs in security; the malls and commercial stores who look for improving their services' offer and advertisement; and the museums who look for knowing which area features are most visited and what not. The stakeholders that are interested in facilitating the implementation of the solution are the carers; they want to know where their dependents are at all times. Their cooperation is crucial to enlarge the coverage area. The city councils look for improving dependents' mobility in terms of their safety and security. The city malls and commercial stores want the carers to spend their time shopping instead of taking care of the dependents. Besides, both city councils and stores could gather information about the behaviour of the people within the city, mall or store for future big data analysis.

II. SYSTEM ARCHITECTURE

A back-end processing cloud service has been developed in order to provide a front-end consisted of a set of web services and a mobile application. The solution is based on a cooperative network of confidence devices. It defines two users' profile with unique

identifiers (ID): confidant, assigned to the carer, and dependent assigned to the child, elderly or disabled. The confidence devices could be dynamic such as smartphones, smartwatches or tablets; or fixed, deployed at strategic locations such as parks or streets in open spaces; and doors, stairs or rooms in indoor environments. The position of the fixed devices is assumed to be previously known, whereas the position of the dynamic devices is estimated by fusing the information gathered by its sensors (GNSS, BLE, WiFi, etc.) which were integrated for non-localisation purposes, but that may be exploited to this end, for both indoor and outdoor public spaces. The confidence device integrates a Bayesian framework that considers both the sensors' information and the dynamics of the confidant. This way, the dependents' position will be estimated by processing the received signal strengths (RSS) gathered at the confidence devices in range of which positions have been previously estimated/known. Therefore, each confidence device will update periodically a table with its ID/position, and the ID/RSS of each bracelet in range. All the confidant tables are sent to the command and control centre (in the cloud) where the position of the dependent is computed using once again a Bayesian framework which in this case considers both the RSS and the dynamics of the dependent. The higher the number of confidence devices, the larger the coverage of this network and therefore the higher the probability that a dependent will be accurately positioned.

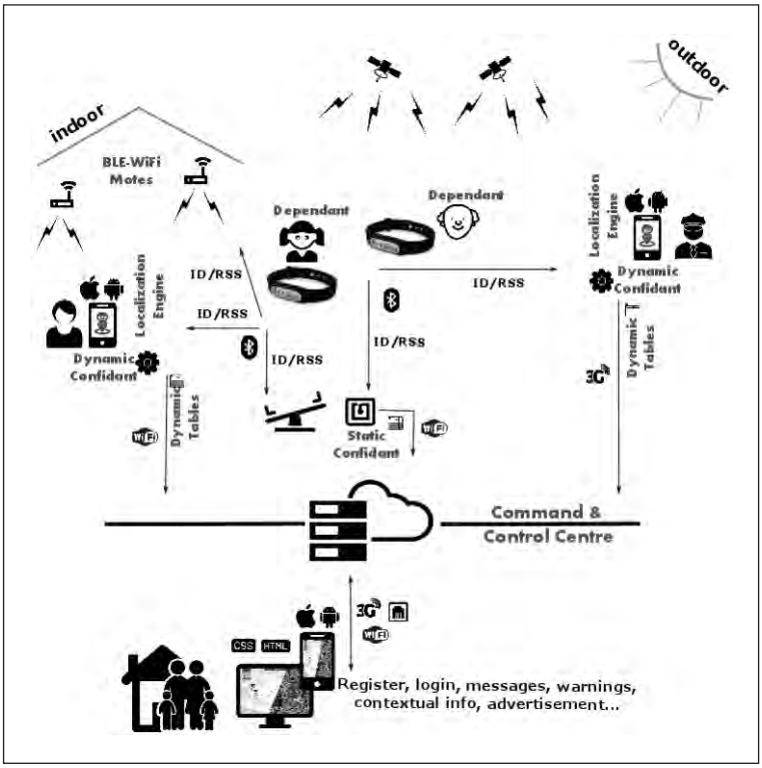

Fig. 1. System architecture. A back-end processing cloud service has been developed in order to provide a front-end consisting of a set of web services and a mobile application.

Fig. 1 represents the main components which describe the system architecture, and the flow chart of the data. These main components are the low-cost BLE bracelet, the BLE-WiFi motes, the mobile application and the cloud which hosts the command and control centre.

A. The BLE bracelet

Fig. 2. The BLE bracelet.

The bracelet integrates a BLE transceiver aiming to broadcast the ID beacon which unambiguously identifies the dependent, the higher the transmission power the higher the coverage but the lower its battery life; an accelerometre aiming to control the time interval between ID beacons, the higher the dependent's activity the lower the time interval, and vice versa; and a vibration sensor aiming to warn the dependent that something happens.

B. The BLE-WiFi Mote

A number of confidence fixed devices have to be deployed to guarantee minimum system coverage because it depends on the network of confident devices, and the dynamic confident devices such as smartphones depend on the number of enrolled carers. Fig. 3 shows a fixed device, it integrates two wireless technologies: BLE and WiFi. The BLE acts as the interface between the dependent (the BLE bracelet) and the carer (in this case a fixed mote), while the WiFi acts as the interface between the carer (in this case a fixed mote) and the command and control centre hosted in the cloud. Both interfaces share a buffer to interchange the data. The BLE interface fills the buffer with the selected BLE IDs and its corresponding RSS belonging to the enrolled bracelets. The WiFi interface empties the buffer whenever the IDs/RSS info is sent to the command and control centre. The BLE-WiFi mote could be powered by a battery supply or directly to the mains power depending on the environment. Likewise, the command and control centre could send messages to the BLE-WiFi motes aiming to restart them, update their firmware, change their state between idle and wake-up, etc.

Fig. 3. BLE-WiFi mote.

C. The Mobile Application

The core of the mobile application is the localisation engine which performs seamless localisation estimation of the carer's device in real time by fusing the information collected by all of its sensors. Nowadays, the smart devices such as smartphones, smartwatches or tablets already integrate a GNSS receiver, a WiFi and Bluetooth adapter, a camera, and most of them will soon integrate other sensors such as the barometre, inertial sensors or the proximity contactless technology NFC. Therefore, taking into account these sensors' information and the dynamics of the carer, a Bayesian framework is used to estimate the position of the carer [16]. Once the carer's position is estimated, several functionalities based on the context would be implemented. Therefore, the localisation engine would be the ideal platform for developing location-based services that provide the carer with context-based information [17]. Among these services, the mobile application mainly allows the confidant looking up the location of his/her dependents, knowing if they go out of the carers' range, editing alarms in order to better control his/her dependents, and pressing the panic button in case of an emergency, i.e. a missing dependent. If this would be the case, the confidant profile could notify the system asking the enrolled users for enabling his/her confidence devices. Thus, the area of coverage will be enlarged. Fig. 4 shows a general view of the mobile application.

D. The Command and Control Centre

The aims of the command and control centre are to remotely track the position of all the carers and dependents, edit alarms, control the fixed BLE-WiFi motes, and analyse the behaviour of the users. As explained earlier, the position of each dependent is computed in the command and control centre so each confidence device will send periodically a table with its ID/position, and the ID/RSS of each BLE bracelet in range. A Bayesian framework is used to estimate the position of each dependent considering both the RSS and the dynamics of the dependent. Furthermore, this command and control centre could provide the services

based on the context, such as offers, advertisement, advice, etc. Fig. 5 shows a general view of the command and control centre.

III. EXPERIMENTAL SETUP

Vallsur, which is the largest mall in the city of Valladolid (Spain) has been selected as the test location for the proposed solution. This mall is highly concerned with the importance of guaranteeing safety and security for its clients, enhancing the mobility of the dependents into the mall. The experimental setup took place in the second floor where 15 BLE-WiFi motes were deployed trying to cover the common spaces. The test consisted of five dependents and three carers. Fig. 5 shows the position of each dependent in real time over the mall second floor plan. This view can be only seen by the guard of the mall because the carer can only see the position of his/her dependents (see Fig. 4). Additionally, as it is shown in Fig. 5 three alarms were defined, two of them related to dangerous spaces such as the exit of the mall and the access to the lift and mechanic stairs, so every time a dependent would enter into those places an alarm would be sent to the corresponding carer. The last alarm was defined in a recreation area so every time a dependent would exit that place an alarm would be sent to the corresponding carer. Another kind of alarm is shown in Fig. 4; as can be seen from the mobile application view, one of the carers has one dependent out of range and the other within range.

The experimental evaluation of the solution proposed in this work allows the stakeholders to validate the system. Carers could monitor the dependents' positions in real time, giving them more freedom to safely roam within the mall. In this case, their cooperation was crucial to enlarge the coverage area, thus the system consisted of 15 fixed confidence and 5 dynamic confidence devices. The mall gathered information about the behaviour of the people within the mall which helps them to improve their offer and advertisement. Finally, the commercial store owners and managers observed that the carers were more focused on shopping instead of taking care of the dependents.

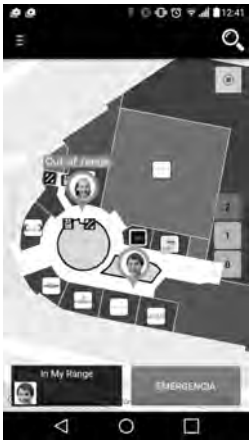

Fig. 4. Mobile application view.

Fig. 5. Command and control centre view.

IV. DISCUSSION

Beside the main goals of such tools providing safety and supporting comfort of people using various places (well-known, less-known, crowded, noisy, etc.), such tool can provide information for spatial-behaviour analysis to inform better practice in design, maintenance as well as surveillance of places. Theoretical backgrounds supporting contemporary research addressing activity behaviours and design of public spaces are mostly grounded in environmental psychology, e.g. affordances [12], and behaviour settings [13], but were gradually adopted for the focused purposes of planning or design (e.g. [14]). Analysing affordances is aimed to understand how the physical environment could influence individuals' activities; whereas behaviour settings refer to regular patterns of behaviour, specifiable by time and place and dependent on the physical characteristics of the place and prescribed social roles for what is expected to happen there.

A further stage of this project foresees the implementation of behaviour mapping-related methods to provide a variety of information about dependent-carer-spatial relationships. Such relationships will be examined on an individual basis, studying each single situation, analysing distances and characteristics of places between carer and dependent to address ease of wayfinding between them, as well as legibility of sequences of places they are involved with. Studying all dependent-carer behaviour patterns in the given area, the project will address cumulative carrying capacity of place for ease to navigate through the place and search for spatial clues, where it is more likely that people could get lost or confused, and how these clues could be similar for different users; different types of dependents and their carers. Thus it is assumed that the implementation of the system (Cooperation Location Network) discussed in this paper can significantly improve information and knowledge about (vulnerable) users in their environments and help to create inclusive design guidelines or recommendations for safe and easy-to-navigate places.

In its essence the ICT approach discussed in this paper is behaviour mapping-based. Originally, behaviour mapping, grounded and well used in the field of environmental psychology [18] is focused on recording behaviour as it occurs in a designed environment. Behaviour map is a product of observation and a tool for place analysis and design at the same time, where spatial features and behaviours are linked in both time and space. Chronologically, some of the most common ways, usually applied in indoor spaces, were systematically writing notes and filling formatted tables, mostly having no connection to actual layout of the observed place. The development of photo-video techniques influenced the latter methods of recording and map production. Nowadays ICT development is forthcoming, offering various ways of recording people's engagement with places. This issue is at the core of this paper, discussing ICT tool, its suitability for automatisation of behaviour mapping, both as process of data collection as well as analytical means.

Authors in [15] discuss three types of behaviour maps regarding their emergence or production: manually (drawn behaviour maps on paper prints produced at sites); semi

ICT-based (digitalised, transmitted manual behaviour maps into their geo-positioned digital version); and ICT-based (GPS device-based behaviour maps, web public participation GIS-based behaviour maps produced in virtual environment). Irrespective of the type to provide a highly informative database, the process of recording behaviour itself needs to be as condensed and inclusive as possible. Accordingly, attributes such as the type of activity, the users' gender and age, duration of the activity, time of the day of occupancy, time of the week of occupancy, movement direction and weather conditions at the presence of the activity; all describe an observed activity in a place. Hence, a coding and counting system needs to be selected before a technique's implementation is addressed. Thus mapping preparation includes a list of some anticipated activities, their assigned symbols and additional coding (e.g. duration, age group). However, the list of anticipated activities needs to stay open-ended for any possible new activities to be added, and attached symbols for these unexpected or infrequent activities to be developed in the course of the observation.

Having gathered behavioural information in time and space, several types of analyses are possible: from straightforward and descriptive in nature such as: How many people access the public space averagely every day?; to more space oriented, such as: Which is the area that is most utilised during weekends?, or Which area features tend to foster exploratory play in children? In this respect the aim of this paper is to provide socially informed concepts and measures for public spaces and to show a potential which ICT driven tools can have for recording and evaluating behaviour patterns and their characteristics; not only to provide safety measures but to address thresholds and evidence-based guidance for urban planning, design and architecture in order to work towards quality of living in cities and towns.

V. CONCLUSIONS

The cooperative location network that has been presented in this paper shows a new service over which carers could monitor the dependents' positions in real time, giving them more freedom to safely roam within the public spaces. Besides the main goals of such digital tool providing safety and supporting comfort of people using various places (be them well-known, less-known, crowded, noisy, etc.), such tool can provide information for spatial-behaviour analysis to inform better practice in design, maintenance as well as surveillance of places. Behaviour maps provide a shorthand description of the distribution of behaviours throughout a place. They are useful if sufficient repeated observation in a place is done. The major value of behaviour maps as a research tool, lies in the possibility of developing general principles regarding the use of space that apply in a variety of settings. Overlapping individual behaviour maps can show some characteristics and changes in using spaces in terms of activities, number of people engaged, gender, and all the other variables that are explored. Focusing on safety and comfort in places, they can also help to provide empirical knowledge about way finding and vulnerable users'

difficulties in specific user-place or user-user situation in the observed setting. Thus there is a challenge to set up and promote a monitoring digital tool which can as much as possible unobtrusively function for users' engagement with places as well as the device/tool itself.

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The Contribution of ICT in Planning of Public Open Spaces

Reflections on the City of Lisbon

Tiago Duarte
Diogo Mateus

Abstract – *This paper discusses the importance of open public spaces, and how information and communication technologies (ICTs) can enhance the understanding of the relationship between spaces and their users, towards the production of inclusive and cohesive urban spaces. The analysis is built on the Project CyberParks, which aims to increase the knowledge about this challenging relationship. Through this, we intend to analyse how these digital forms of communication can help planners improve public open spaces, based on the study case of Lisbon.*

The growth of our cities, throughout history, has always been linked to the public space, and how it was built. Its function was constantly changing, according to the needs that were appearing at different times. However, these transformations were being made with one goal, that of adapting public spaces to their users. What currently occurs is almost an extension of the existing public spaces, by the appearance of enclosed public spaces, for example. And we have some theories that suggest the Internet as a public space.

Nowadays, the use of new technologies is becoming a reality. It is already possible to find public places with free Internet access, often providing an attraction for tourists. It is very common to observe individuals who have smartphones and other portable technologies that are constantly connected to the Internet.

The discussion will be centred on the contribution that ICTs could have to help plan public open spaces, with the presentation of some examples of experiences made with ICTs on improvements of these public spaces. With the technological growth that we have observed, ICT must be used to both improve the participatory methods, and act as a tool to bring people to be more outdoors and use public spaces.

Keywords — public open space, information and communication technologies, users of public space, urban planning, CyberParks.

I. INTRODUCTION

Throughout this paper, we intend to analyse the relationship between digital communication technologies and public open spaces, and how the new forms of communication can be a support to different makers, in order to plan better urban areas. The analysis is based

on the work developed by the COST Action TU 1306 CyberParks, which aims to advance knowledge about the relationship between Information and Communication Technologies (ICT) and Public Spaces, and is focused on studies carried out in Lisbon.

The CyberParks Project establishes an interdisciplinary research platform, including different specific groups working together to understand the relationship between ICT and the production and use of public open spaces, and the relevance to sustainable urban development. In this paper, the studies developed in the City of Lisbon will be addressed, namely comprising the tests of the WAY CyberParks application.

The WAY CyberParks is an ICT tool for monitoring the use of public open spaces that is being developed and tested, consisting of three main elements: a smartphone application (app), a set of web services and the cloud. In Lisbon, this app has been used in some places, namely in Quinta das Conchas Park. A Workshop was held in September 2015, as part of the European Researchers Night. The paper is an analysis of the results obtained, of the app's potential, and of how this type of digital form can help planners to improve public open spaces.

The public open spaces of a city have always been part of its identity. Moreover, the development of our cities has always been conditioned by the type of public space. Different types of public open spaces necessarily imply different growths. Several authors make reference to the important need for communities to have attractive and inclusive public spaces.

Public open spaces must be prepared to receive the community, where their relationship can be strengthened, and a sense of belonging cloud be fostered. They are representative spaces, with a civic and political action [1] , and that have the function to condition the economic development and drive environmental sustainability [2].

Nowadays, it is usual to see people using digital communication devices in public spaces, as smartphones or tablets for phoning, reading, searching, sending emails, taking pictures and making movies, and so forth. This is a big challenge to the different specialists, from ICT developers to social scientists and urban designers [3]. The challenge is to be able to use these new forms of communication and use them as a tool to support decision making in planning, production, and maintenance of public spaces. For that, it is necessary to create tools that can be used by the users, and could access users' needs in a public open space.

By having access to the needs of the users, it is easier to find solutions for the different spaces, making them more suitable to the respective needs, thus resulting in an increase in the tool's use. And given the way our society has developed, where leisure time is increasingly reduced, it is essential to create more inclusive spaces and adapted to the needs of its users, reversing the trend of people being locked at home, in their virtual world.

The challenge could be summarised by a key question posed by Thomas [4] in her blog: "Can we capitalise on our new-found love of the wired life to encourage more people to go outside?" Could we use this relation with ICTs to bring more people to the street and the public space?

II. THE CONTRIBUTION OF ICT IN PLANNING OF PUBLIC OPEN SPACES

One of the principles of the "New Charter of Athens", revised in 2003 [5], refers specifically to the use of new information and communication technologies (ICT). This is in line with the objectives of CyberParks. The leading questions in CyberParks Project are: 1) What is the contribution of ICT to transform our cities into more social and inclusive environments, rather than just more high-tech?; 2) What opportunities does ICT offer to better understand the way people use the public spaces?; and 3) How can ICT provide support for those involved in the production, design, and maintenance of public spaces? [6]

Using this new ICT, decision-makers have the possibility to understand the needs of communities, and make changes in order to bring more users to public spaces. In some cases, these needs are new, supported by new ways of life. The role of decision-makers is to understand these needs, and create public spaces that are more attractive. The use of ICT in planning of public open spaces must be seen in two ways: 1) as a support to the study and technical development (production); and 2) as a tool to be used by the community, in order to improve public participation in the planning proposals, and in the promotion and exchange of knowledge [3].

According to Thomas [4], the world is increasingly dependent on digital technology. The digital penetration in our outdoor lives is quite high, and it is envisaged to become stronger So, we must take this research opportunity and create a tool to study public open spaces. Also, the possibility of interaction with the users provides a new way of communication, which is much more effective and fast, achieving in this way an interaction with users, not only realizing their needs, as well as interacting with possible solutions. Thus, the ability to plan a more attractive and adequate space it is the priority

Together with other means that may be considered by planners, ICT can be a good tool to improve the way planners work. However, we must not consider this as being the only way to provide data. Fieldwork, for instance, cannot fail to be considered. But ICT has some important benefits for those who need to plan and study a space.

In this paper, we shall describe one of the existing tools that can be used by planners to support the decisions and the planning of public open spaces. As discussed above, the tool is WAY CyberParks application (app), an ICT tool for monitoring the use of public open spaces, which is being developed and tested and which consists of three main elements: a smartphone application (app), a set of web services and the cloud. The users of the app have the possibility to send information about a space, by using different tools provided, such as their GPS location that allows seeing the routes used the suggestion box, and specific information resulting from questions that may be undertaken.

III. REFLECTIONS ON THE CITY OF LISBON

Inserted in the CyberParks Project, and similar to other countries involved in the project, some studies in Lisbon have been developed, which aim to analyse the way ICT can be

used in the planning of public open spaces. Although in this article it is intended to give more prominence to the workshop held last September at Quinta das Conchas Park, other activities that have been carried out are also noted.

The first studies to be conducted concerned the tests in the Quinta das Conchas Park and Principe Real Garden, during the first meeting of Cyberparks in June 2014. At the time it was possible, using the participants of the meeting, to carry out some observation tests of both places. In each of the spaces, the participants had to answer a questionnaire on paper, which aimed to understand how they used each of the sites, which routes were adopted, and their opinion regarding the use of a digital tool – in the case of Quinta das Conchas this comprised the WAY CyberParks, while the use of GPS was used at Príncipe Real Garden. Participants were asked to complete the questionnaire at the end of the visit.

Unfortunately it was not possible to access data collected by the app WAY CyberParks through the Web platform, and therefore only the data collected by GPS devices became available. The data analysis enabled the confirmation of an interaction between what is real and what is virtual, and their complementarity. Using GPS devices confirmed a trend: attractive spaces, a pleasant atmosphere, an inviting space that offers different possibilities for activities tend to be used more and more often by individuals who spend more time on site – in short, what can contribute to greater social coexistence with all its implications, such as identification, sense of belonging, social integration, etc.

Subsequent to this activity, other spaces are being prepared some in order to be analysed in more depth, using the app WAY CyberParks. Among these sites are the Quinta das Conchas Park, and a rehabilitated neighbourhood called Ameixoeira. The more advanced preparation is Quinta das Conchas Park, where tests have already been made. One of the tests was the workshop, inserted in the European Researchers Night, and the results are presented below.

IV. WORKSHOP QUINTA DAS CONCHAS PARK – RESULTS

The Researchers' Night is an initiative promoted since 2005 by the European Commission under the Marie Curie Actions, in order to celebrate the Science and approaching citizens. Taking advantage of the possibility of CyberParks Project to join this initiative, some of its members were present during the evening on the 25 September 2015, in order to disseminate the project among citizens, as well as other research groups, and within the activities developed before this event, there was a workshop called "WAY CyberParks app – Há Ciência em Lisboa" (WAY CyberParks app - There Science in Lisbon).

The organizers and representatives of CyberParks Project were CeiED / ULHT (Interdisciplinary Centre for Studies in Education and Development / Lusófona University) and LNEC (National Civil Engineering Laboratory), with the involvement of four researchers: Carlos Smaniotto, Diogo Mateus, Marluci Menezes and Tiago Duarte.

The workshop had 15 participants, and aimed to test the application WAY CyberParks. Despite the number of participants, only 9 used the app, after having created groups. The collected results were processed and analysed, and presented in the Researchers' Night held on September 25, and each participant could verify the tool's potential, and their participation in the project.

The proposed workshop included the following steps:

1. Description of WAY CyberParks, its features and objectives of the Workshop;
2. Visit to Quinta das Conchas Park, wherein each participant was asked to use the freeform space, requesting only to test WAY CyberParks during the visit;
3. At the end of the visit to the park, participants were asked to answer a short questionnaire about the use of WAY CyberParks.

As mentioned above, the results were presented at the Researchers' Night.

The data collected in the workshop was as follows:

- Tracks / routes of each user;
- Information placed in the suggestion box of app;
- WAY CyberParks questionnaire, about the visited space;
- Written questionnaire on the use of WAY CyberParks.

Thus, the collection of this information was intended to test the different features of WAY CyberParks, and obtain an analysis of the participants on the use of this application. Of all features, the answers given by the users of WAY CyberParks questionnaire were not available, due to an informatics problem that prevented the collection and appropriate storage of information provided by users/participants.

A. Tracks / routes of each user

WAY CyberParks main function is the tracking of users on a particular public space, using for this purpose the GPS embedded in smartphones, giving the location of each of the real-time users. This function has the main advantage to understand how users use the public space, which routes they adopt, as well as the duration and distance travelled by them.

Through the results, we can observe the areas of public space with more or less occupation, and the timeline associated with them, for example. This type of analysis can provide several indicators, such as the quality of each of the public space areas, thus helping assess possible measures to be taken to improve some places that do not have, or having a reduced, occupancy.

In the specific case of the Quinta das Conchas Workshop, although the area under study contemplated the total area of the Quinta das Conchas and Quinta dos Lilases, we found that participants/users remained for a longer period of time in the central area of Quinta das Conchas, and the more used route was between this central area and the lake of Quinta dos Lilases. The forest area in the east of Quinta das Conchas had a practically nil

use. The reasons for this type of use could be various, and can be explained by the very specific type of users, which in most cases occurred in a group, thus seeking more populated areas of the study area, unlike the North area of Quinta das Conchas, that provides a quiet and isolated stay, and that forest, which has a predominance of users who practice sports, such as running. In the specific case of Lilases, mostly characterised by isolated stay, it was found that only its central area was used, as a passageway.

It is possible to see in Figure 1 an example of the route travelled by a user, and in Figure 2 the behavioural map of the most used routes. It should be noted that this information is available automatically on the Web service of WAY CyberParks app.

Fig. 1: Website WAY CyberParks (http://services.cyberparks-project.eu/): user route and distance travelled.

Fig. 2: Website WAY CyberParks (http://services.cyberparks-project.eu/): behavioural map.

In the specific case of this Workshop, the duration of the route was similar for all users, not allowing one to draw conclusions, a normal situation because it is an event like a set schedule. Moreover, it was found that the distance covered on average was 3.000 m, and that the shortest distance travelled by a user / participant was 1.575 m, up until 5.181 m, and in this particular case also moved to an area outside the selected location.

Briefly presenting some observations of this feature:

- Participants have chosen to go mostly to the central area of Quinta das Conchas;
- The forest area was only covered by a participant (area dominated by users who practice sports);
- The average distance travelled by participants was 3.000m;
- The average duration of the visit was 2.5 hours (Workshop duration).

B. Information placed in the suggestion box of app

One of the features of WAY CyberParks is sending suggestions in the form of text, image, video or sound, which will be sent to a web platform, further processed and analysed, enabling the development of actions to improve the use of public space.

In the case of the held Workshop, participants were encouraged to use this tool in order to indicate the strengths and weaknesses observed. The sound sending functionality was the only one that was not used. This feature was also used to support the quiz app, where a specific response was necessary, according to a previously selected option. Since it was not possible to access the results of this questionnaire, we cannot associate the suggestions with the answers given, and which ones were made spontaneously. Table 1 illustrates the type of suggestions that have been made, in particular regarding the type (positive or negative suggestion), the given title, and the form used for sending (text, image, video and/or sound).

As mentioned above, the sound feature was not used and only a video was placed. Most suggestions were made through text and image, and the use of text and image on the same suggestion was the most used option.

In summary, regarding the use of this feature, we have:

- Functionality with a relevant use = 17 uses;
- Most of the uses served to observe negative points = 11 (about 65%);
- Only one equipment suggestion was sent;
- It allows the researchers to check quickly and easily the opinions of users regarding the public space

TABLE I. SUGGESTIONS PLACED IN THE APP

TYPE	TITLE	TEXT	IMAGE	VIDEO	SOUND
Suggestion	bench + bin quinta das conchas	as above	Yes	No	No
Negative Point	land flooded	Sprinkler has flooded lawn.	Yes	No	No
Negative Point	Ground	The ground is very dry, very brown	Yes	No	No
Negative Point	Dirtiness	Many cobwebs on the boards.	Yes	No	No
Negative Point	Trash	There is some trash on the floor	Yes	No	No
Negative Point	dry lake	quinta dos lilases lake is no water	Yes	No	No
Negative Point	picnic area	picnic area completely cold and empty of life. it's not attractive to use.	No	No	No
Negative Point	play areas	play areas vandalized	Yes	No	No
Negative Point	Lake and surrounding area	This lake does not look any lake. The area is not attractive to sit or rest. It's ugly and nothing attractive. It looks abandoned.	Yes	No	No
Positive Point	drinking fountain	Positive point of park.	Yes	No	No
Negative Point	Quinta dos lilases	Quinta dos Lilases does not seems to be managed by the same entity of the Quinta das Conchas due to their degradation and lack of maintenance.	No	No	No
Negative Point	Quinta dos Lilases Park	Park needs more maintenance	No	No	No
Positive Point	watercourses	No	Yes	No	No
Positive Point	futebol	No	Yes	No	No
Positive Point	futebol video	No	No	Yes	No
Positive Point	lampost	lamp	Yes	No	No
Negative Point	Lack of cleanliness	Take some firewood	Yes	No	No

C. WAY CyberParks questionnaire about the visited space

One of the objectives of the participants in the workshop was to respond to questions on the WAY CyberParks app. The questions were distributed throughout the study area, and were automatically activated when each user passed through their area of influence. The answers to these questions were intended to ascertain the views of different participants, concerning various aspects, from the sense of security of certain areas to framing the type of user, in particular the way that was taken to the park and the distance from where they lived, among others.

The questions included in the WAY CyberParks are indicated below:

- What is the reason for your visit to the park?
- How often do you use the park?
- How long do you usually remain in the park?
- What is the distance from your residence?

- What route do you use most often to go to the park?
- Do you consider that existing buildings (cafe, restaurant) are well framed in the Park?
- Is the playground well framed in the Park?
- Do you consider that the playground could be improved?
- What elements do you like most in the park?
- How do you rate the degree of safety of the park?
- Do you consider that those who live near the Park have better living conditions?
- Do you consider this large grassed area to be suitable to the park?
- Do you consider the waterlines to be an attraction for the park?
- Do you consider that the internal paths of the park are well distributed?

A few more questions were asked in the proximity of some places, asking respondents' opinion if, for instance, they liked the lake and the picnic area.

Unfortunately, we could not get the answers given by the users because of a computer problem associated with the WAY CyberParks web service. It is to be noted that the associated problems have already been solved, allowing one to conclude that this event is not likely to happen again. Although it has not allowed us to obtain answers, because it is a feature that was to be experienced for the first time in this particular place, the result of the on site analysis through conversations with participants allow us to make some other observations that should be considered for future situations.

First, there is no user who has answered all the questions. Although respondents have not gone through all the areas where the questions were, the main reason given for non--response is related to the failure to realize that the notification was in the question's range, and after checking that it appeared in the app, since the users were already out of this range, it was no longer permitted to answer. Once the location of the questions was not the knowledge of the participants, they could not go back to where this question had been launched.

Although not answering all the questions cannot be considered a negative aspect, it should nevertheless be the subject of reflection, and in particular with regard to: 1) the number of issues; 2) their distribution over space; and 3) possibility for users to have access to the location of questions (as in points of interest).

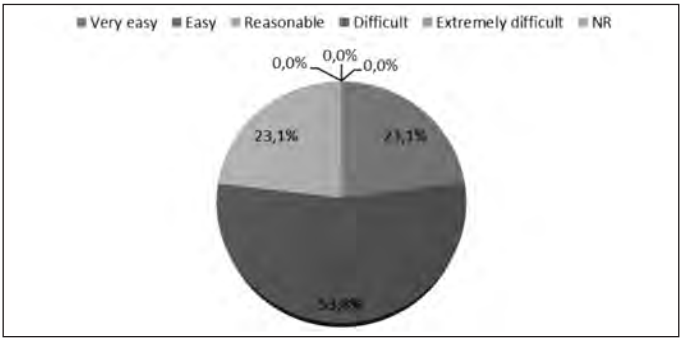
D. Written questionnaire on the use of WAY CyberParks

Taking advantage of the fact that this was a workshop with a group of previously registered people, and in order to obtain information about WAY CyberParks app, and possible aspects to improve, a written questionnaire allowed us to collect this type of information. The questionnaire was provided to participants at the end of the workshop, and answered on site. We have 13 questionnaires that were completed, with a collaboration of 54% men and 46% women, emphasizing a balance between sexes. In terms of age of the participants we find that the average age was 28 years, with the most older participant having 42 years

and the youngest 12 years. The predominant age group was 20-29 years, within the average age mentioned above. The results in each of the questions are shown below.

Question 1: How do you rate the use of the WAY CyberParks application?

The results indicate that none of the participants considered the use of WAY CyberParks difficult or extremely difficult. Still, a percentage of 23.1% considered its use only reasonable, the same percentage considered it to be very easy. Most users consider the use of easy application. The results obtained in this question (as well as others) are of great importance because of the need to have an application that is easy for users to understand, and it is desirable that they use it without any aids, as was done in this Workshop. The positive results obtained allow us to conclude that the group of participants considered that the application WAY CyberParks is easy to use.



Graphic 1: How do you rate the use of the application CyberParks WAY?

Question 2: Do you consider that interesting and relevant questions were posed by the application WAY CyberParks along the way?

Another concern of the workshop organizers was to figure out whether the type of questions asked in the application would be an asset, and if the participants felt that these would be relevant. Although the results of the questionnaire WAY CyberParks application have not been available in the Web application service, the participants/users had the opportunity to use this feature. Although they have not been able to answer all the questions, the result obtained in this question was quite enlightening, with no negative responses and the percentage of 92.3% positive responses.

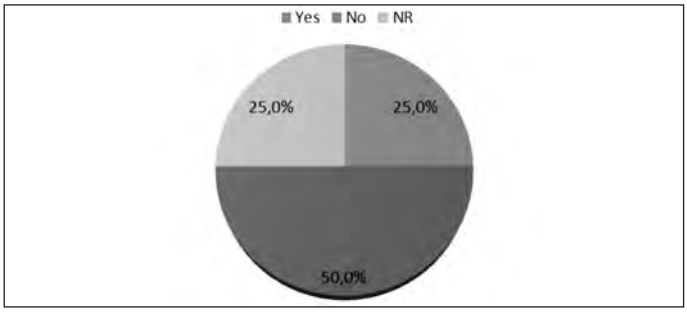
In this question, together with the option of 'yes / no', the reasons for the selected option were asked. For the positive answer that was given, we could outline some of the justifications:

- It is a way of knowing what people consider to be an asset to the park;
- Used to understand the user's profile, which is useful for adjusting park needs;
- Allows to get more direct opinions of users;
- Yes, although I think that some of the questions could arise regardless of the visited area;
- Help to know the park and through the application can help/suggest new uses for certain zones thereof;

- Stimulate greater observation of space;
- Awaken the interest of the public space

Question 3: Do you think that there should have been some other questions?

To the question whether other questions should have been placed, half of the participants answered negatively, considering appropriate the amount of questions. About 25% of participants consider that there should have been other questions, the same percentage of those who chose not to respond.



Graphic 2: Do you think that should have been some other questions?

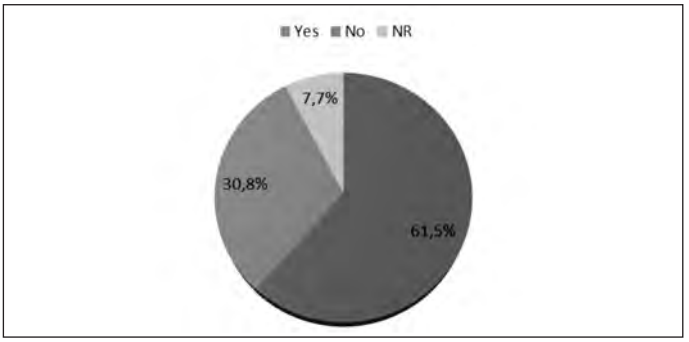
In the questionnaire, participants were given the opportunity to indicate what questions should have been made. Although not all participants who have opted for this answer have indicated a new question, some of the ones that have been proposed are presented below:

- Questions should have different solutions and desires of the user;
- Reasons why the people go to the park;
- Place where they came from.

The contribution of possible questions to ask enables two types of analyses. In the specific case of the first contribution, the participant reinforces the need for the questions to be more specific, such as what they consider would look best in a particular area of the Park, with specific solutions. While some of the questions asked were in this sense, this type of observation may be an indication that there could be more questions about transformation solutions of certain areas of the Park. On the one hand, the last two questions posed were inserted into the survey application. This contribution may be linked to the fact that users have not had access to all issues, as explained above. On the other hand, the need to make some questions visible should be rethought, and whether that could be an asset to our analysis.

Question 4: Do you have any suggestions to improve WAY CyberParks application?

One of the main function of the distribution of this questionnaire was to obtain suggestions to improve the app, so the kind of questions mostly went in that direction. Most participants responded affirmatively, about 30% of respondents consider that the application does not need improvements, and 7.7% did not answer.



Graphic 3: Do you have any suggestions to improve WAY CyberParks application?

Some of the suggestions made by users include:

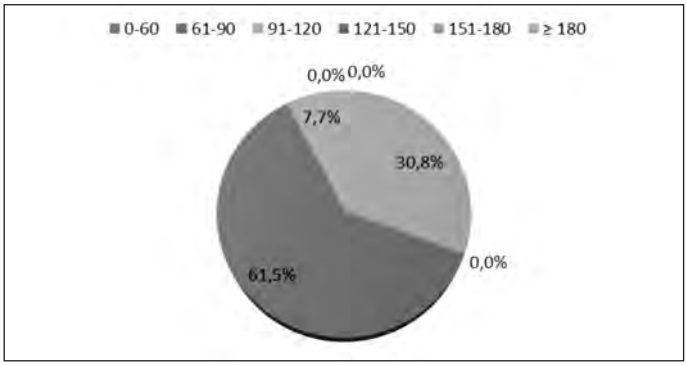
- Sounds for notifications of questions and other alert situations;
- Notifications with vibration;
- Application in Portuguese;
- Vibration and sound with the application minimized;
- System that rewards users to offset the battery spending;
- Improve interface;
- Automatic sending information when the application is used in offline mode;
- Improve the placement of photographs in the suggestion box, due to blocking problems in offline mode.

Suggestions of various kinds were obtained. On the one hand, there were a few that are not amenable to improvement, as is the case of sending information automatically in offline mode, as this mode only works with the phone's GPS, there were others that should be taken into account in maintaining the application, with particular focus on questions of notification issues, particularly in the modes of vibration and beeping when they enter the range of action of a question.

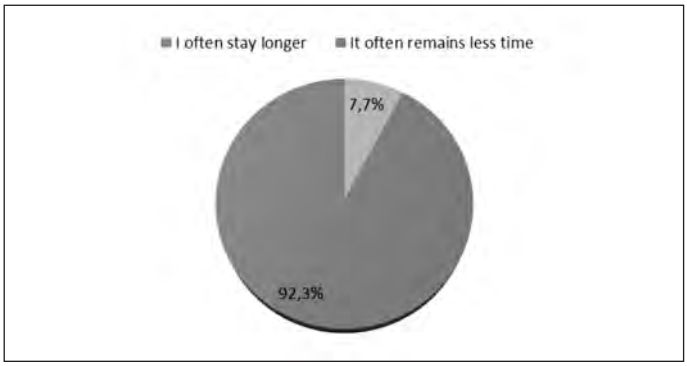
Other suggestions address the possibility of the application to be in Portuguese, a situation which seems unlikely. Still, it is indicative of the need for this to be in Portuguese, and which should be taken into account in future situations, particularly with regard to the conditioning of the results. Finally, one must mention the suggestions that consist in rewarding the users for using the application, in the specific case to compensate for battery depletion. In the specific case of this workshop, the results were presented at the Researchers Night, having immediately a "reward" by making the results available to participants.

Question 5: How long did you remain in the park? (Minutes)

Question 5.1: Is this time more or less what you usually spend in the Park?



Graphic 4: How long did you remain in the park? (Minutes)



Graphic 5: Is this time more or less what you usually spend in the Park?

In addition to the issues directly related to the application, the questionnaire also had some framework questions such as the length of stay, presented here. Because it is a workshop with a predefined duration, the results were mostly similar (121-150 minutes) and there are small derivations of a shorter duration (91-120 minutes) in the case of participants who had to leave early and longer duration of participants who remained in place for an extended period (over 180 minutes).

The placement of the issue 5.1 intended to realize if the time that one usually stays in the park was higher or lower than indicated in question 5. The answers were almost entirely that in a normal situation the participants remain periods of time lower in the park, could be concluded that this group only stayed longer because of the Workshop.

Question 6: The use of the WAY CyberParks application allowed discovering something new in the Park?

To the question if the WAY CyberParks application was responsible for the discovery of something new at the park, 53.8% of users responded affirmatively. It was requested to indicate what was discovered, which includes the following:

- Using the application made me know better the park;
- The application puts us more attentive and observant of what surrounds us;

- Despite not having discovered new things, I rediscovered many of them;
- Quinta dos Lilases and Park amphitheatre;
- A lake, the ducks, the forest, the airport nearby.

The participants, through the use of the application, in some cases found new areas, such as the Quinta dos Lilases and improved their perception of the entire park and its surroundings. On the other hand, it was also noted that, by using the application, critical sense and observation about the positives and negatives of the park were stimulated, a situation that is easy to understand because it is a workshop that started with the description of application and its goals.

Question 7: Other comments and suggestions

The last question of the questionnaire provided to participants, was the placement of other comments and suggestions they consider relevant regarding the WAY CyberParks application. We present below some of the comments and suggestions that were made:

- Better dissemination to the population. Publicity in the Parks with internet point for downloading the app;
- Where answers were given an icon should appear to prevent others to give the same suggestion. The report could arise when selecting the icon, and people could "like" or "dislike" either agree or disagree with the criticism;
- Thanks for the opportunity! I think it is a very interesting application to take advantage more and "discover" the parks.

Although it has been a little option used by the participants (only 20% used this possibility), the observations allow assessing the need for users in the application to target a wider spread among the population. Basically, fulfilling what was intended with the realization of this Workshop and the presence in the Researchers' Night. The suggestion of giving "likes" and "dislikes" to other users' proposals, at least at this stage of investigation, does not seem feasible, although the same should be considered in the future.

V. CONCLUSIONS

The use of ICT allows a new approach in the planning of public open spaces, in order to create more attractive and inclusive spaces in our cities. Throughout history, the public spaces were being responsible for the identity of our cities, having different functions from the social point of view. Currently, users of these spaces have new needs, and planners have the responsibility to adapt to these needs.

The great challenge, through the use of ICT, is to promote interaction between users and decision makers, to improve public spaces, adapting them to the needs of its users, and above all promoting the existence of new users. By improving public open spaces, we are encouraging healthier living habits, contributing to improving the living conditions of the population.

The use of the application WAY CyberParks, according to its characteristics, has the means to make a significant contribution to the study of public open spaces. The type of results produced allow to quickly and efficiently collect a set of data that may be essential for improvement in existing spaces, and as support for new spaces. The workshop results analysed here allowed us to verify that. Although it was not possible to obtained all the data, including the questions placed in application, other information were essential to be able to draw some conclusions about the improvements that can be made in this application. The next steps to be taken include increasing the use of the application in several case studies, including those mentioned in this paper. These case studies will strengthen the assessment of the relevance of digital media in the study of the relationship between public space and its users.

ACKNOWLEDGEMENT

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The integration of an augmented reality module within the Way- Cyberparks App.

The case study of Valletta city.

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Abstract – *Latest improvements on mobile devices capabilities are changing the way people interact with their surroundings. Nowadays, devices are able to sense the environment and user's location, enabling the user to experience improved digital services. This is a key aspect of public spaces enhancement, which plays a pivotal role for the improvement of public spaces; a key to make public locations more accessible, interactive and enjoyable. One of the most powerful technologies enabling this innovative set of services is known as Augmented Reality (AR). More in depth, AR allows users to visualise in real time virtual information about the physical objects of the real world, directly on the display of their own devices. AR provides innovative way-finding widgets and context-awareness services. Along with the aims of the COST Action Cyberparks, our aim is to improve the App delivered during the first stages of the project (Way-Cyberparks) with AR functionalities, by developing a location-based AR module tailored to be integrated within Way-Cyberparks. The AR section will link virtual geo-tagged annotations as an interface to (geo) spatial and attribute data, allowing users to quick access digital sensory inputs. The overarching idea is to populate the App with virtual signage fostering the fruition of public spaces by allowing users to experience new ways of moving within specific places. Thanks to that, on one hand, the App works as an interactive path-finder tool, heading visitors towards the most interesting locations or landmarks within a specific area (Points of Interest or POIs). On the other, users are enabled to create their own contents and upload them into the network of available POIs, enabling a true participative community. The city of Valletta has been chosen as first case study; here the AR module will be tested to identify historical locations and heritage buildings, acting as contextual objects for the Way- Cyberparks App.*

Keywords— Cyberparks, Augmented Reality; Smart Tourism; Way-finding; Context Awareness; Tracking

I. INTRODUCTION

Location-based Augmented Reality (AR) is becoming one of the most powerful cutting edge technologies for tourism. Among other features, AR has the capability of changing users' sight of the environment and this is the main reason of its increased usage by the users. Furthermore, the potential of mobile devices is growing with impressive speed, changing the way in which tourists gather and access information, especially in outdoor environments [1]. The worldwide adoption of mobile devices by the users has replaced traditional orientation, guides and way-finding maps. This is mainly because built-in cameras, global positioning system (GPS) sensors and Internet connection open the way towards a new manner of experiencing public spaces, thanks to contextual information. With context-awareness services tourists have access to interactive experiences and, even if with little knowledge of a certain area, they can naturally experience unfamiliar places. The trend of AR apps is growing, even if some aspects prevent them from becoming the main medium to explore outdoor spaces. Of course, maps are a good solution to find places and interesting areas in outdoor spaces. However, even if well-established solutions, they are not optimally designed for urban exploration and provide limited capabilities to access data; moreover, and more important, they oblige the user to look away from the reality. For urban environments, available 3D maps have the limitation that the camera view of the object is often occluded by nearby structures, which is especially problematic in densely built-up areas [2]. In contrast, AR represents a natural choice for exploring location-based information of real world objects, mainly because information can be superimposed onto the display, with the same point of view of the user. If one is equipped with an AR-enabled mobile device, simply by framing one's surroundings into its direction, one can easily access additional information about a Point of Interest (POI) in an urban environment. A good "vademecum" of the the challenges that developers have to take into account when designing AR browsers for outdoor environments are listed below [3];

a) many objects can be augmented with information;
b) each object can be a source of a substantial amount of information;
c) contents might be visually heterogeneous and dynamic;
d) tourists are walking through unknown places that might impede a natural way-finding;
e) tourists have information needs which differ from those of urban residents.

In recent years, many AR systems have emerged. However, most of these systems are designed for small indoor environments, since many limitations like brightness variation, occlusion, 3D registration, can be managed in a simpler way [4]. The development of AR applications for outdoor scenario implies the use of built-in sensors, handy and widespread for the most of devices, but error-prone in terms of accuracy.

In this light, and along with the scopes of the COST Action Cyberparks, our aim is to improve the App delivered during the first stages of the project (Way-Cyberparks) with AR functionalities, by developing a location-based AR module tailored to be integrated within Way-Cyberparks.

The AR section links virtual geo-tagged annotations as an interface to (geo) spatial and attribute data, allowing users to quickly access digital sensory inputs. By populating the platform, the app has become the container of virtual signage, fostering the fruition of public spaces, by allowing users to experience new ways of moving within specific places. Thanks to that, on one hand, the App works as an interactive path-finder tool, heading visitors towards the most interesting locations or landmarks within a specific area (POIs). On the other, users are enabled to create their own contents and upload them into the network of available POIs, enabling a true participative community. The city of Valletta has been chosen as first case study; here the AR module will be tested to identify historical locations and heritage buildings, acting as contextual objects for the Way-Cyberparks. AR and mobile technologies would represent the milestone for the outdoor learning experience for Cyberparks.

The aim of this paper is to describe the pipeline of work used for the development of a learning experience to be experienced in an outdoor environment. This implies the need to consider several aspects, mainly focused on the optimisation of the showed content. Numerous tests have been performed in order to optimise the contents (meaning file format, aspect ratio, gestures etc.) and the user interaction with them. The design of this experience has been conducted in a close cooperation developers and designers, to enhance the usability of the app.

II. RELATED WORKS AND PROJECTS

A. Research and projects

AR is able to attract a growing number of visitors, since it offers an innovative concept for exploring outdoor areas; it is also an affordable and simple solution for insiders (e.g. guides, administrators, etc.) who can enable new solutions, offering new information and management methodologies to simplify access to public areas, expanding the range of promotion and dissemination services. Starting from the territory, AR can take the user into other domains, evaluating the entirety of the cultural heritage (CH), encouraging a deeper exploration of diffused heritage goods [5]. From the e-learning standing point, Mobile Augmented Reality (MAR) has proved to be a winning solution [6]. However, some technological and anthropological issues still exist, preventing MAR from becoming a broadly used tool for open spaces. External variables that influence user acceptance include enjoyment, personal innovativeness, perceived benefits, costs and information quality [7].

In the following, a brief state of the art review is reported. Current issues and benefits of using AR for tourism purposes, highlighting the benefits offered to the tourists, are widely discussed in [8]. Authors state that the core idea behind the use of AR for tourism is the enhancement of users' perception of reality and of the surrounding environment. Tourists in fact are exposed to unfamiliar environments where the fast retrieval of information is fundamental for our decision-making. Access to relevant contents through location-based

services not only facilitates this process, but also changes the way we perceive destinations, creating more memorable and unique experiences. Recently, a lot of attention was directed towards AR interfaces as a suitable visualisation paradigm, especially within the domain of travel and tourism. AR browsers deliver (geo) spatial and attribute information about physical objects through spatially registered virtual annotations. Such interfaces reduce the need to translate abstract information (for example, encoded in maps), or oblige switching views between information and physical space. This happens with guidebooks or list-based mobile interfaces. This scenario is particularly beneficial for time-pressured visitors to unfamiliar locations. In [9], interesting consideration has been done, with respect to the criteria that should be used when developing an AR service for tourism. Four features should be followed:

a) Readability: labels should be readable at all times and should not overlap;
b) Unambiguous association: labels should clearly refer to their target objects;
c) Aesthetics: labels should be placed in a way that prevents visual clutter;
d) Frame-coherency: the system should provide a seamless transition of content among frames.

Many examples and available applications still exist. In the following, a brief explanation of existing applications for many domains, based on location tracking is reported, with particular focus on tourism.

B. AR for tourism and cities.

The use of AR solution is spreading between countless fields of application. Its intuitiveness and ease of use make it suitable, among others, for Medicine, Maintenance, Learning, Cultural Heritage and Tourism. The latter can particularly benefit from MAR, as demonstrated by the existing commercial solutions, reported in the following:

CorfuAR[2]: is a tourist city guide using the strengths of the AR technology, by placing digital information about surroundings upon the screen of the device. The experience of visiting Corfu is enhanced with virtual information about sights, museums, monuments, religious sites, nature and many more.

Augmented Walks: visitors can view 3D reconstructions of monuments or buildings, on the screen of their devices or Head Mounted Devices (HMD) which capture through the camera the surroundings superimposing 3D virtual models of monuments.

Ename 974[3]: project for the study and promotion of the Belgian village called Oudenaarde, visualising 3D models of the monuments inside the archaeological site. Navigation is conducted through a predefined path close to the excavations, allowing one to view the virtual reconstructions superimposed on the real scene exactly on the foundations. In this way visitors are helped in both observation and understanding of the original structures.

[2] http://www.corfuar.com
[3] http://www.enamecharter.org/initiative_1.html

Archeoguide [10]: provides the user with the opportunity to observe in the real world 3D reconstructions of monuments, obtaining additional information during the visit of archaeological sites or places of interest. For example, several national parks in the US have added AR stations to view distant archaeological sites and other inaccessible places overlapping information and reconstructions on the real fossils.

PRISMA [8]: project still under development with the aim of enriching the real scene with interactive multimedia information and of increasing the user's tourist experience, who can retrieve this information from a user-friendly interface.

Fu-Jen University mobile campus touring system [11]: A prototype to increase tourism has been developed and reviewed by two focus groups on the campus of Fu-Jen Catholic University. AR provides hidden information of the campus in the area, providing students with immediate assistance in case of losing and also representing a mobile learning tool.

Lecce AR[4]: it is an interesting example of visualisation of 3D models during a visit for city environment. It allows adding to a real-world scene, seen from a mobile device's camera, with 3D models of cultural heritage sites as they looked in the past. 3D models are displayed when the user points the device's camera towards a planar target which can be a photograph or an image.

III. ENABLING TECHNOLOGIES

AR is a technology that enables the visualisation of digital contents above a screen, with the same point of view of the user. Hence, AR systems can be classified according to device /display typology (mobile, wearable, head mounted, haptic, etc.). Furthermore, to permit a device displaying a virtual object, as if it exists into a real environment, it must be able to sense the environment and track the viewer's movement and orientation. This procedure is called tracking. Even if the afore-mentioned technologies are well established, technical impediments exists, ranging from hardware capabilities to the availability of reliable connection infrastructure. 3D models are often huge and the displaying of multifaceted items represents a hard task. Finally, from the human point of view, the hampering lies in the interaction and human resistance to changes.

A. Tracking system

The number of tracking systems is growing (the more innovative are acoustic, inertial, edge modelling), but the widely adopted are positioning and optical based (respectively sensor- and vision-based). Especially used for outdoor tracking, sensor-based approach relies on global positioning system (GPS) receiver embedded into commercially available devices. Once the system gets the user coordinates, it is able to display POIs in a predefined location; the registration process is possible thanks to other sensors such as gyroscope, compass and accelerometer for a more accurate superimposition of contents or model. The

[4] http://vcg.isti.cnr.it/LecceAR/

estimation of user's position in indoor scenario is generally performed adopting vision-based approaches. Once the field of view of the camera coincides with that of the user (e.g. in video see-through) a pixel registration is implemented for a precise overlapping of contents. If just few years ago this process based on artefacts landmarks (e.g. QR code), nowadays the possibility to process images in real time is well established, implementing image matching algorithms (Liu, Yang, Sun, & Liu, 2008), to reach the so-called markerless AR. Robustness and responsiveness depend on the adopted platform and device capabilities, but results of vision-based approaches (hybrid and/or markerless) for general cases still represent the best in quality solution for AR.

B. Technological challenges

Technological challenges encompass a different aspect that depends on devices and infrastructures. It is well known that, nowadays, a growing number of commercial mobile phones and tablet are available; this introduces the problem to make apps fitting for both kinds of devices. However, screen size and aspect ratio change from one another, forcing developers to consider this aspect from the very beginning of the design of the app. Furthermore, different devices mean different operative systems and platforms, widening the spectrum of solutions and making the cross-platform development difficult. Also computational capabilities cannot be managed in advance; since a real time rendering requires good hardware performances, planning applications for a wider range of user means finding a balance between complexity and efficiency. Internet availability is another obstacle for AR experiences, especially for outdoor settings. If the application needs to retrieve remotely stored contents, the user needs to rely on his own Internet provider. On the one hand, out-of-range areas prevent the use of the application; on the other hand, limited bandwidth could make difficult loading files.

C. Available tools

During the last year a growing number of Software Development Kit (SDK) have emerged, providing developers with tools and libraries. A comparison[5] of the most diffused SDK shows that iOS and Android solutions are the most compatible. It also interesting to note that the number of free tools is greater than the commercial ones, even if the latter have become well established. For the purpose of this work several platforms have been tested; below is a brief report of our research.

Mixare (Mix Augmented Reality Engine) is a free open source AR browser, which is intended to display contents of Wikipedia. However, it can be personalised with own contents from a remote GeoData Base (Geo DB).

DroidAr is a framework for AR, specifically designed for Android only. Location-based AR and marker-based AR are both possible.

Wikitude and **Layar** are the leading commercially available tools. They provide professional services and features that make the development more stable and efficient.

[5] http://socialcompare.com/en/comparison/augmented-reality-sdks

IV. THE PROJECT OF THE APPLICATION

This study explores how handheld digital devices like smart phones or tablets can provide instances of engagement in 'Smart City' learning within or in the vicinity of Valletta. The core objective of this work is the development of a learning experience, focused on the city of Valletta and exploiting the functionalities of AR browser, as explained in the previous sections. More in depth, we have dealt with the improvement and on the integration of contents within the existing WAY-CyberParks App.

A. Learning experience

This innovative technology-enhanced learning approach is being used to promote mobile learning about Maltese History and Botany. Using an interactions-based methodology, mobile learning activities were designed to be managed through the Android-based WAY-Cyberparks App (freely downloadable from Google Play). This App is being used, in the context of the Cyberparks COST Action 1306, to develop location sensitive mobile learning experiences. Besides the Navigation tracing and Geo-Activation functionalities, the App will provide further location-based AR services. Considering these functionalities, a number of GNSS-based learning activities were designed for identified locations in Valletta with the specific pedagogical objective of promoting different modes of Smart City Learning (Playful learning, Seamless learning, Geo-learning, Citizen enquiry and Crowd learning). The App will also be used to mediate, trace and record user-generated (learning) interactions as triggered by the prescribed App-based activities. GNSS-based learning activities were developed for two different sites in Valletta: the Argotti Botanical Garden in Floriana (just outside Valletta) and the Upper Barrakka in Valletta, a site providing picturesque views of the Grand Harbour and the surrounding Cottonera region.

B. Implementation

To implement these functionalities, it is necessary to identify the POIs within the area of influence of the learning experience. A web-service has been specifically designed by DeustoTech Mobility research Unit[6] (Figure 1) allowing a smart and agile addition of POIs. During this first stage, we produced a report describing the places, contents and contextual information of the City of Valletta, [12]. The stage of conceptual design served to identify domain, type of learning and outcomes. Also the interaction design was taken into account, with the objective of providing a mediated experience between the content and the real environment. Multimedia resources (e.g. commentary texts, digital images, video clips and audio tracks) were chosen and assigned to the pre-defined POI. The identification of technical requirements was compulsory for the integration within the WAY-Cyberparks app.

In Figure 2 the POIs selected for the case study of Valletta are illustrated.

[6] http://mobility.deustotech.eu

Figure 1: The web services

Figure 2: The addition of Points of Interest into the web service

The second stage of the work consisted of the set up of the learning experience; images and content, related to the POI, were developed and inserted through the web service (Figure 2). Problems were mainly related to the size, format and typology of the images, so that several tests were conducted to achieve the best results in term of visualisation and responsivity of the app. After an initial phase of testing and adaptation of the contents, we implemented the learning experience storing the POIs and the related information, dividing them into sub-categories. The mobile app is based on a localisation engine to retrieve the user location, and an AR engine for the visualisation of contextual information. All the features available from the web service have been used for developing the location-based services (LBS) that will provide the participant with the learning experience

in Malta with context based information; Figure 3 shows the POIs chosen to be enriched with additional information. Since the position did not allow performing the app in the real scenario, we used a fake positioning service, in order to simulate the latitude and longitude coordinates of the site where the experience will be carried out. In Figure 4 a screen shot of the app running during the tests is shown.

In occasion of the *iCiTy Conference*, which took place in Malta as the mid-term conference of CyberParks project, people were asked to test the application in situ. Once the users arrived into the predefined area, augmented contents (i.e. audio track, archival images and so on) were shown in AR mode. The feedback from these panelists is positive, since they found the use of this type of experience very useful for outdoor scenario and to have deeper information of the surroundings. Some images of the test performed in La Valletta are reported in Figure 5.

Figure 3: Upper Barrakka and Senglea Point, POIs of the application

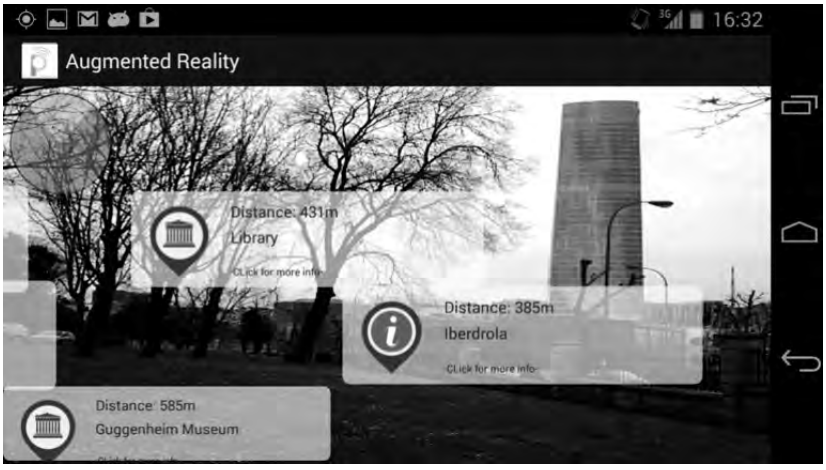

Figure 4: The mobile application running in outdoor scenario to test the functionalities.

Figure 5: The mobile tested by the users in the real environment.
On the left the Upper Barrakka site, on the right the garden of Argotti Villa.

II. DISCUSSION

During the development, several issues arose, with respect to the technical limitation that state of the art technologies highlight. Displaying and clicking POIs appearing in AR mode is strictly dependent on the platform and on the device, and making them work for all of them is a very time consuming task. File's size depends on a device's performances, and of course, on the available connection bandwidth. To overcome this problem, we stored all the contents into a separate folder, which can be downloaded in advance with a free Wi-Fi connection. Finally, POIs positioning depends on the GNSS receiver accuracy and, even if deviations of up to 7-8 m are possible, they are satisfactory for the purposes of the proposed learning experience.

Also a prospective outlook of state of the art technologies has been presented, which demonstrates how similar solutions are useful to trigger a more interactive experience for public areas, especially for tourism purposes.

III. CONCLUSION

In this paper we outlined best practices useful for the development of location-based AR applications. An interactive route guidance through AR as designed and implemented, ready to be run for the case study of the City of Valletta; the core idea is to populate the existing Way-CyberParks App with POIs. LBS serve as guide for the tourists towards the main attractions, scattered among public parks and historical areas. The database containing the POIs has been enriched with metadata, in order to categorise the various cultural goods. The recuperation of urban parks means, first of all, persuading people to visit them; by providing users with digital tools, making their visit more interesting, fun and simple, this objective should be pursued. With our solution tourists will discover the space more easily. The simplicity of the architecture further eases a constant updating by the public administrations.

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A Connectivist Approach to Smart City Learning:
Valletta City Case-study.

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Abstract – *A connectivist approach will be adopted to design and evaluate learning in technology-enhanced open spaces in Valletta city. Learning is considered as a process of creating connections between learner's inner cognitive and affective systems with the external physical and social worlds. These interactions are organised within a model comprising dimensions and levels of interactions. The experience for a learner in a technology-enhanced historical place will be designed considering interactions with the content domain (history, botany, art), the technological dimension (interaction between handheld devices and the available signals such as 3/4G, Wifi or GNSS) and the social dimension comprising interactions with fellow learners /citizens and domain experts. The levels of interactions are related to learner's experience within the subject domain, with technology and one's status or role in learning community or community of practice. Thus learning experiences have to be designed considering acquisition level for novice learners, participatory learning for more experience learners and contributory learning for highly competent learners. This connectivist model will be applied to identified places of historical or educational interest in Valletta city to design different modes of learning mediated through interactive technologies. The concept of Personal Learning Environments in Smart cities [1] will be used to provide technology-enhanced experiences in Playful learning, Seamless learning, Geo-learning, Citizen enquiry and Crowd learning.*

A number of these technology-enhanced learning experiences, developed in collaboration with CYBERPARKS ACTION's WG1, will be contextualized in Valletta city. University of Malta will provide the domain content and resources, together with the pedagogical strategy for each learning experience. Researchers from WG1 will design and develop the technological model and infrastructure, mainly the Android-based Way-Cyberparks App that will integrate GNSS-based learning, Augmented Reality, Navigation tracing and other functionalities used for specific tasks and type of data collection. An interactions-based methodology will be used to evaluate learning along the identified dimensions.

Keywords— Smart City Learning, Connectivist pedagogy, Mobile Learning, Augmented Reality, Technology-Enhanced Learning, Cyberparks.

I. INTRODUCTION: SMART CITY LEARNING

The combination of emerging digital technologies together with citizens' increasingly elaborate digital competence is radically changing every aspect of our lives – how we interact with our physical and digital surroundings, how we communicate, learn, share knowledge and experience, how we socialize and entertain ourselves. The increased levels of flexibility, immersion and engagement provided by ubiquitous digital technologies, social media, virtual and augmented reality are continually challenging our established pedagogical models and directing us to consider innovative approaches and learning ecosystems. The infusion of all dimensions of our lives with digital technologies is leading us to live a 'Hybrid Reality' [2] through our interactions with the 'Internet of Things and People'. This 'Hybrid' mode of living in a technology-intensive environment increases the pedagogical potential of these contexts with strong impact on both formal and informal learning.

Technology-enriched environments support the vision of Smart Cities by influencing and improving key factors like mobility, environment, people, quality of life and governance. In Smart Cities, learning is not only a way to train an adequate human capital, but becomes one of the driving forces of the 'smartness' and well-being of a community. Buchem & Perez-Sanagustin [1] define smart city learning from a human-centred perspective as the 'learning experience of locally and globally interconnected citizens who use smart technologies to learn by using, sharing, remixing and co-constructing learning resources, and in this way actively contribute to solving societal, environmental, political and economic challenges'. The same authors claim that "From this perspective, the 'smartness' of the learning environment is determined primarily by the citizens and their uses of smart technologies rather than technologies themselves" Unavoidably, the underlying and ubiquitous techno-ecosystems - whose embedded intelligence, sensitivity and responsiveness surround the individuals - challenge the future of learning and call for a redefinition of spaces, contents, processes, skills and assessment approaches.

The potential of Smart cities to serve as an open macro Personal Learning Environment [1] comprising a wide range of localized micro learning contexts triggers reflection about how these macro and micro PLEs can be enhanced and enriched through digital technologies. The idea becomes even more exciting when one considers capital cities, like Valletta in Malta, that are endowed with a plethora of artistic, historical, architectural and cultural heritage. Combining this resourceful physical environment with the versatility of digital technologies can provide an intensive and comprehensive learning experience that contrasts with formal learning contexts that citizens might have experienced many times and possibly criticized.

Learning in such open environments is profoundly different from that occurring in formal contexts like the classroom. This compels learning designers to look for new conceptual and theoretical frameworks that describe these experiences from a different perspective

to teacher-driven, didactical approaches that characterize formal education. Though instances of constructivist (learning through exploration, experimentation and collaboration) and constructionist (learning by designing) may also be included in the formal curriculum, learners are only marginally involved in the planning, management and evaluation of their learning. On the other hand learning in Smart cities draws more on a connectivist epistemology [3] that focuses on 'connections' created through digital technologies.

Learning in connectivist technology-enriched environments is characterized by a complex system of interactions comprising various dimensions. The mere presence of a person in these places evokes interactions with domains of knowledge, such as History, Archaeology, Architecture, Science or Technology that are actually prompted by ad hoc interests. Subsequently this provokes a hybrid interactive experience involving the physical environment, the mediating technological infrastructure and other learners or experts present in or connected to that particular context. The underlying epistemology, pedagogy and contextual characteristics of these 'smart', connectivist environments are disparate and many times contrasting to classroom situations.

From an epistemological perspective, smart city learning contexts are characterised by a shift from knowledge representation and simulation to learning by immersion and embodiment [3] of the situated, hybrid experience. In classroom situations, static representations of objects and simulation of processes are negotiated assuming a direct positive correlation between degree of fidelity and learning. Yet this comprises learning through indirect experience using static or animated representations. Learning in Smart city contexts is the outcome of an immersive and highly interactive hybrid activity through which both personal and distributed knowledge is acquired, created and shared. This immersive approach leaves in learners, not only intra-individual cognitive and affective residues, but most important a networked personal experience forming part of the distributed knowledge and expertise that resides within digital systems. Each immersive learning activity in Smart city contexts creates intra-individual connections with learner's sensory-motor, cognitive, affective and conative systems that describes the idiosyncratic experience in that particular place at a specific time under specific external conditions. But it also creates inter-individual connections that describe the social experience comprising interactions with people sharing the same physical space and those connected through mobile devices.

Learning in Smart city contexts is also distinguishable in its organisation and management. While most learning in formal educational contexts is teacher-structured, teacher-managed and predominantly teacher-assessed, learning in Smart city contexts is mostly not prescribed, though prescribed activities can be used as triggers for further explorations and elaborations. Moving away from set curricula and structured activities, it is primarily formulated, managed and evaluated by the learner mainly through ad hoc interactions and improvised personal learning plans. Technology is exploited, not to simulate learning in an environment, but to enhance the immersion, interaction and connectedness of the learner with the surrounding and distant environment. "When mediated through technologies, e.g. by means of mobile

and locative media, the surrounding physical environment and the digital environment can be dynamically merged into augmented, ad-hoc Personal Learning Environments which are not permanent, but created ad-hoc and adjusted dynamically by connecting virtual and physical spaces" [1], p1.

While classroom learning is very static and confined, learners in Smart city contexts are provided with enhanced mobility, interaction and control possibilities. This dynamic environment gives rise to the phenomenon of 'glocality' – "where the local and the global coexists" [4]. Mobility and interaction in Smart city contexts is manifested along different dimensions. Sharples *et al.* [5] differentiate between mobility in the physical space, mobility of technology, mobility in conceptual space, mobility in social space and mobility in time. Through this mobility learners are able to capture and share personal learning experiences in new ways that enable new forms of learning across multiple contexts [6].

In this connectivist setting, interactivity is mediated by the existing technological infrastructure, personal digital devices such as electronic tablets, smart phones, wearable digital gadgets and any task-dedicated apps. Interactions in the identified contexts in Valletta will be mediated through GNSS or Wifi-enabled devices equipped with the Way-Cyberparks App that enables users to interact through various communication channels and actively participate in multi-directional conversations. It also enables *Crowd learning* [1] that harnesses the knowledge of 'surrounding' people and utilizes "the power of the masses" to support learning experiences. Apps like 'Foursquare 8.0' and its companion 'Swarm' create information flow between the crowd and the learner who can access the expertise of the crowd at anytime and from anywhere through the personal device.

Such dynamic, immersive, hybrid environment is capable of supporting *multiple-objective learning* enabling learners to follow personal objectives and learning patterns. At one moment it could be an information-seeking interaction using augmented reality, followed by an exploratory activity on the same App that attempts to establish relationships between concepts, ideas or events. Playful learning is another learning approach mediated by pre-designed interactive systems or Apps that introduces the competitive and fun elements in the learning experience. The Way-Cyberparks App can be used to promote *citizen enquiry* [5] to blend inquiry-based learning with active citizenship as a way to create knowledge and awareness about relevant social issues.

The interaction possibilities created by the integration of digital technology in open physical environments leads to *multi-context learning*, which enables not only learning anywhere and anytime, but also combines physical and virtual spaces transforming urban elements into learning resources [7]. Sharples *et al.* [5] refers to this as '*Seamless learning*' that extends the learning experience beyond the boundaries of time and location, blending learning with everyday life. '*Geo-learning*' is an instance of seamless learning that utilizes context-aware and position-based technologies to add interactive points and layers of digital information to physical spaces. This offers the possibility of interconnecting locations

and social settings, and facilitates the exchange of information across contexts [8] For example both the Aurasma and the Cyberparks Apps could connect learning contexts by moving themes explored in the classroom to outdoor settings from which further data, observations, media footage and context analysis are taken back to the classroom to enrich lessons and elaborate the learning experience.

Smart City connectivist learning contexts demand a paradigm shift in learning design approaches. Current prescriptive learning design models are inappropriate to capture the complexity, dynamism and unpredictability of learning in such contexts. Learning design models that empower learners to design and organise their mobile learning experience are more applicable for these technology-rich, highly interactive, evolving scenarios. The role of teachers and learning designers thus shifts from prescribing (instructional) activities, on basis of identified needs, to providing the digital (pedagogical) infrastructure and resources to be used by the learner for designing and managing one's personal learning plan and experience. It is not a prescription based on task and content analysis but one based on analysis and identification of processes and interactions that will underpin potential learning experiences [9]. Moving beyond designing structured activities, dimensions and levels of interactions are used as design elements to develop possible patterns of interactions made available to visiting learners who will use them to develop their seamless, inquiry-based, playful, glocal learning experience. This design approach also makes use of emerging technologies and digital resources which are evaluated and employed in smart city learning contexts considering the learning processes they are capable of mediating that will eventually empower learners to develop their (ad hoc) learning plan and experience.

So, the research questions underlying this investigation about mobile learning in an urban context are:

- How does the Way-Cyberparks App mediate user interactions with the surrounding physical and digital environments?
- Which further user-generated interactions are triggered through the use of the Way-Cyberparks App?
- How can one evaluate the potential of the App in promoting different modes of learning?

II. METHOD

This study explores how handheld digital devices like Smart phones or tablets can provide instances of engagement in 'Smart City' learning within Valletta city. Mobile learning activities have been developed for two different locations as shown on the next image.

Upper Barrakka Gardens is a site that provides picturesque views of the Grand Harbour and the surrounding Cottonera region. This was selected to develop a mobile learning experience about a historical event that took place at Senglea Point (on the opposite side of the Grand Harbour) during the Great Siege of 1565.

Senglea Point as seen from the terrace of Upper Barrakka Gardens:

Source: https://www.schulfahrt.de/blog/2010/03/15/malta-eine-insel-zwischen-geschichte-und-moderne/

The other site is Argotti Gardens in Floriana, just outside Valletta city. This was chosen to develop a mobile learning experience about the History of the Gardens and various botany-related themes. The two mobile learning activities were designed to be managed through the Android-based WAY-Cyberparks App (freely downloadable from Google Play) which is being used, in the context of the Cyberparks COST Action 1306, to develop location sensitive mobile learning experiences. Besides navigation tracing and geo-activation functionalities, the App was further developed by the technical team to integrate Augmented Reality (AR) [10] that could be activated through the Global Navigation Satellite System

(GNSS). Using this customised App, two GNSS-activated learning activities were designed for the identified locations with the specific pedagogical objective of promoting the different modes of Smart City Learning discussed above. The App will be also used to mediate, trace and record user-generated (learning) interactions as triggered by the prescribed App-based activities.

Thus a visitor to any of these sites can use the WAY-Cyberparks App on the Smartphone or tablet to learn about a number of proposed themes. When the visitor enters a pre-defined area and is in a pre-defined orientation in terms of GNSS coordinates, the WAY-Cyberparks app notifies the visitor with a welcome message proposing four activities which one can activate by selecting the relevant icon on the screen of the smartphone. Each of these options leads to an Augmented Reality-based category of interactions, namely interactions about 'History' of the location, about 'Structures' in the location, about 'Processes' occurring in the location and also suggestions for follow-up activities as a 'Reflect' activity. The user opens the camera of the smartphone to frame a target object or location and starts interacting with it through any of the four proposed options. On selecting any of these, the user will have different media options (text, images, audio, video) superimposed on the view window of the camera. For example, s/he will be provided with digital images of maps and models that are superimposed on the real background. The objective is to enable the user to develop a better understanding of the composition and function of particular structures or the chronology of a particular event linked with that place. Through the 'Reflect' option the App will propose other on site activities and activities to be carried out in other locations where user can continue his/her explorations and inquiry. The App will provide access to different on-line media management tools and social networks to enable and record further user-generated interactions.

III. SMART CITY LEARNING SCENARIOS

The following mobile learning scenarios are being designed to be piloted in two identified sites at Valletta. The conceptual design will identify and discuss the different dimensions of interactions in relation to the predominant mode of learning being promoted through the customised Way-Cyberparks App.

A. A Botanical Experience at Argotti Gardens, Floriana

The mobile Learning Activity (MLA) about the history and botany in Argotti Gardens was designed in collaboration with the site curator Dr Joseph Buhagiar. The WAY-Cyberparks App is customised to inform and provoke reflection about History of the Garden, important structures and botanical processes in the Argotti Gardens. These include reproductive processes of Endemic Trees and botanical collections found in the Garden and the water irrigation system. The 'Reflect' option attempts to extend this informative and reflective activity beyond the site through further questions and suggestions.

A visitor at Argotti Gardens is offered a number of mobile learning activities through an App-based map showing flagged 'Points of Interest' (PoI). Standing at the entrance of the Garden, a GNSS-activated introductory session welcomes the visitor and gives important information about the layout of the site, highlighting the flagged PoIs. The visitor is then invited to roam in the Gardens visiting the PoIs while commenting and recording his/her experience through photos, audio commentaries or text-based descriptions. In case the visitor has access to the internet through his/her mobile phone, these are communicated and shared in identified on-line applications such as Twitter, WhatsApp, Quattro, Facebook, or a personal blog or website. If there is no access to the internet, any comments and created media can be sent when connecting to internet. The objective is to use the prescribed GNSS-activated learning activities to provoke Citizen / Learner Enquiry, Crowd and Seamless learning. The following is a proposed interactions template describing type of learning as a function of interactions with the domain (Botany and History), technology (Way-Cyberparks App and web-based applications) and Community (co-learners including other on-site visitors and those within on-line social networks).

B. Interactions template for Argotti Gardens

Location details	Argotti Botanical Gardens, Triq Sarria, Floriana, Malta. GNSS coordinates: 35.892216,14.503554, (WGS84)
Targeted Smart City Learning	Primary: Geo-learning, Citizen/Learner Enquiry Complimentary: Seamless and Crowd learning

	DOMAIN	TECHNOLOGY	COMMUNITY
Acquisition of Knowledge and Skills	Facts and Concepts about: • Argotti layout • History of Argotti • Identified endemic tree - *Gharghar* • Cacti & Medicinal botanical collections • Argotti irrigation system	Understand the concept of GNSS based learning. Acquire skill in using: • Way-Cyberparks App and addon • Augmented Reality functionality. • Use mobile device to follow GNSS triggered location based media overlays.	Discussion within on-site task groups/on-line collaboration groups about: • How to use mobile device to activate geopositioned learning activities. • The identified domain facts/concepts/themes.
Contributory learning (sharing ideas, creations and reflections) about learner identified queries and themes	For each of the identified domain queries and themes: • Take photos to include in documentary. • Identify info (facts) about each of the documentary themes.	Use relevant applications to record textual, image, audio and video (text editor, built-in camera, sound recorder). Use of Apps embedded in WAY – App to share reflection and creations. Use of online Apps & social media to share knowledge and reflections.	Communications with experts and interest groups in botany, history and architecture. Share creations and documentaries with other site visitors and online.

To promote these learning interactions, the WAY-Cyberparks App will be customised through four clickable options that will be available on mobile interface, mainly 'History', 'Structures', 'Processes' and 'Reflect'. The following tables describe the content and related resources to promote insight, understanding and reflection about identified domain themes.

The 'History' function:

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Images of: Bailiff Ignatius de Argote et Gusman; Knight/Grandmaster Emmanuel Pinto de Fonseca; Plan of Villa in Argotti Gardens.	History of: Private villa in Argotti Gardens. Garden and collections.

The 'Structures' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Structural plan of Argotti Gardens	Description of labelled plan of Argotti Gardens
Images of various Nymphaea	Structural and functional features of various nymphaea found in different countries to explain the concept of a Nympheum.
Irrigation system plan; Video of underground cistern reservoirs	Discussion of the need for large water reserves to irrigate gardens during long periods of warm and dry climatic conditions.

The 'Processes' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Digital image/s of the stages in life-cycle of identified endemic tree: Sandarac Gum Tree (Sigra tal-Gharghar).	Use of overlying digital images to describe different stages during the reproductive cycle of the endemic tree referring to leaves, flowers, fruits and seeds.
Digital images of botanical collections.	Use of overlying digital images to describe different moments during the reproductive cycle of the Cacti and Medicinal plants collection (referring to leaves, flowers, fruits and seeds). Pictures of any products developed from plants in collection.

The 'Reflect' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Annotated map showing other public gardens in the vicinity of Argotti.	Questions to reflect about visit. Suggesting other activities to be carried within or in the surroundings of the Argotti Gardens (e.g. visiting other gardens in Floriana and Valletta).

C. An Experience in History at the Upper Barrakka

This learning activity was developed in consultation with historian Dr Emanuel Buttigieg, an expert on the history of the Knights of Malta. He suggested developing a mobile learning experience about the attack by the Turks on Senglea point in June 1565. The terrace at Upper Barrakka in Valletta, overlooking the Grand Harbour, provides an excellent viewpoint on Senglea point across the harbour. This historical event is well-documented in paintings,

engravings and diaries from direct witnesses. Thus a visitor standing on the terrace close to the lift of the Upper Barrakka in Valletta, facing Senglea point across the harbour, will be notified by the WAY-Cyberparks App with a welcome message proposing four activities which user can activate by selecting the relevant icon on the smartphone interface after opening the camera of the mobile. Each of these four options leads to an Augmented Reality-based category of interactions, namely interactions about the history of this event, interactions about key structures in the location at the time of the attack, interactions about processes that took place during the attack by the Turks, and suggestions of other activities to extend user's experience beyond the prescribed site and activities. After confirming access to App, a resource template is activated on the mobile device that guides the user though suggestions to identify the location, structure, special features (or their absence) and other details as compared to historical documentation displayed on screen or referred to in audio / video commentaries. Different moments during the attack can also be reconstructed through the appropriate media displayed on the mobile/tablet. These proposed interactions are described in more detail in the table below.

Interactions template for Senglea Point

Location details	Senglea Point, Grand Harbour, Malta GNSS coordinates: 35.892482,14.501515,18z
Targeted Smart City Learning	Primary: Geo-learning, Citizen/Learner Enquiry Complimentary: Seamless and Crowd learning

	DOMAIN	TECHNOLOGY	COMMUNITY
Acquisition of Knowledge and Skills	Facts and Concepts about: • The Great Siege of 1565. • The military installations in the Cottonera region. • The military organisation and role of Senglea Point in the Great Siege. • The Turks, their assault strategy and tactics. • Outcome of the Historical event.	Understand the concept of GNSS based learning. Acquire skill in using: • Way-Cyberparks App and addon • Augmented Reality functionality. • Use mobile device to follow GNSS triggered location based media overlays.	Discussion within on-site task groups/on-line collaboration groups about: • How to use mobile device to activate geopositioned learning activities. • Facts and concepts for the identified domain themes related to this historical event.
Contributory learning (sharing ideas, creations and reflections) about learner identified queries and themes	Develop digitally enhanced artefacts about any of the domain themes to enrich your knowledge and share with others. Develop a short media enriched documentary about any of the following roles: • Knight leader • Knight soldier • Turk soldier • Local spectator (from Fort St. Angelo).	Use relevant applications to record textual, image, audio and video (text editor, built-in camera, sound recorder). Use of Apps embedded in WAY – App to share reflection and creations. Use of online Apps & social media to share knowledge and reflections.	Communications with experts and interest groups in History, Military Engineering and Maltese Heritage. Share creations and documentaries in class and on-line.

The following tables describe the content and related resources to promote insight, knowledge acquisition, knowledge sharing and reflection.

The 'History' function:

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Lucini engravings	Highlights of the attack on Senglea Point describing how this fits in the sequence of events of the 1565 siege.

The 'Structures' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Siege Model	Buildings and military structures at SP. Conditions of fortifications, palisade, chain across to St Angelo.
Perez d'Aleccio frescoes	Commentary about structures from Aleccio's Frescos.

The 'Processes' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
Siege Model	Conflict amongst Turkish military leaders Departure of boats from Marsa Range of Cannon fire Effect of obstructive tructures
Siege Model Photos to show perspective from high vantage point and from waterline.	Commentary about the account of the siege including perspectives other than those of Balbi on the events.

The 'Reflect' function

MEDIA OVERLAY IN APP	INFORMATION PROVIDED (DISPLAYED TEXT OR RUNNING COMMENTARY)
	Questions to reflect about event. Suggested follow-up activities, (Eg. visit Siege model in Maritime Museum, Vittoriosa.)

IV. EVALUATING 'SMART CITY LEARNING' MEDIATED THROUGH THE WAY-CYBERPARKS APP

The different modes of Smart City Learning (SCL) designed to be mediated through the WAY-Cyberparks app have to be evaluated through a Connectivist interactions-based methodology as detailed in [11]. A valued technology-mediated learning experience is considered as a function of five factors: Pedagogy, Content, Community, Technology and Metacognition. This proposes an assessment framework for SCL that organised interactions along three dimensions. In line with the learning design methodology adopted in this study, the interactions recorded in the App and associated on-line tools can be categorised into the domain, technology and community dimensions. Each dimension comprises two

categories of interactions: those at the experiential level and those at a metacognitive level. The former include all interactions with the external environment, mediated through specific digital tools that comprise task-oriented and person-oriented activities. Interactions at the metacognitive level include all those intra-individual or collective reflections about the activities at the experiential level. But these experiential and metacognitive interactions are determined by the pedagogical orientation of the (technology-mediated) organizing context in this case the identified modes of SCL.

These modes of SCL will be assessed considering the type, frequency and directionality of interactions. Interactions along the domain dimension will be categorized according to content or task analysis characterizing the Associative design approach [12] considering the hierarchy of learning outcomes (facts, concepts, rules, procedure, problem-solving; psycho-motor skills, cognitive strategies; and attitudes).

Along the technology dimension interactions with the 'surface' and 'deep' structure of the digital tool or environment will be considered in relation to the acquisition of domain knowledge and skills and to one's participation and collaboration in knowledge building and sharing. The surface structure deals with the physical features of the Way-Cyberparks App, mainly interface layout, menu options, navigation and other action tools. The deep structure considers the interactions mediated by the App with the internet of objects, people and locations.

The evaluation of the Community dimension analyses the *type*, *frequency* and *directionality* of interactions for assessing App user's evolving role and identity. Interaction patterns can be developed to determine one's evolving role within the learning group starting from the basic receiver role that moves on to a supporting, guiding and ultimately to a leading one. Type, frequency and directionality of interactions can also be quantified using learning networks such as those linked to on-line collaborative tools or social networks.

Through this process-oriented methodology the interactions profile of an activity or a user can be created. If this profile is linked to adaptive assessment systems involving pedagogical agents capable of analyzing and comparing interactions profiles and patterns against stored data based on previous experiences of the same user, an adaptive Smart city learning system can be developed. Such adaptive systems can be used to propose lines of action for the learner to further his/her inquiry at the same site or beyond. Thus this process-oriented approach provides one example for promoting the pedagogical shift that considers Smart Cities or technology-enhanced open spaces as Personal Learning Environments.

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Simulating bodily movement as an agent for the reactivation of forgotten open air spaces in the city

Georgios Artopoulos

Abstract – *This paper presents experimental work that uses immersive technologies for engaging users and local communities in the design process of architectural interventions on historic, fragmented environments in an effort to re-activate the place under study. In addition to the use of cutting-edge methods of capturing and analysing on-site information, this research framework, implemented in the on-going study of Paphos Gate area of historic Nicosia which lies on the infamous Green Line that still divides the city, explores the potential of narrative-led visualization to enable personal interpretations of space and its history. This virtual environment hosts reconstructions of the Paphos Gate neighbourhood which were produced based on archival material and via 3D data acquisition (LiDAR, UAV and terrain Structure-from-Motion techniques), in order to explore the associations between the transformation of the monument through the years – from its construction to present day – and the bodily experience of the visitors sojourning in its surrounding part of the city. The vision of this research is to develop a digital platform which through immersion, cinematic language and storytelling will enable the evaluation of alternative scenarios and design interventions in the context of the management plan of forgotten open air spaces that used to be popular within their urban fabric.*

Keywords— Social sustainability in smart cities; imersive technologies; interactive narrative-orientated participatory design; built heritage; re-activation of forgotten urban spaces

I. INTRODUCTION

This paper presents an on-going research that integrates digital tools of documentation - used in conservation and preservation studies - with state-of-the-art immersive technologies to contribute new practices of urban space reactivation and enable interdisciplinary contributions to site management. In this context, an interdisciplinary team of experts on archaeology, architectural history, urban studies, virtual environments, spatially distributed storytelling and computational simulations from the Cyprus Institute, is collaborating with the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign, with the support of Cyprus Department of Antiquities and the Municipality of Nicosia to develop a virtual platform that enables urban space simulations. This research uses as a pilot project the study of an important area of the historic city of Nicosia, one of the remaining divided capitals. The Paphos Gate, baring a complex history, as an integral part of the iconic Nicosia fortifications –one of the very few examples of heritage acknowledged by both Greek-Cypriot and Turkish-Cypriot communities - located directly on the buffer zone, used to be in decay for many decades, laying forgotten and detached from both the historical and contemporary city fabric.

This research pursues two objectives, one is to support scholarly inquiries regarding the history and cultural value of the place [1], including educational opportunities for tourists and locals alike, and the other aims at the experimental use of immersive technologies for the re-activation of the area of the Paphos gate – and its re-association with the fabric of Nicosia. This paper is occupied with the presentation of the latter - more information regarding the use of ICT in heritage sites as a means to contribute to the transformation of historic areas of the city into open air museums can be found elsewhere [2]. This research considers the physical space of the Paphos Gate as a staged urban environment, which can be explored in context only through interacting with spatialized narratives offered to its users through immersive experiences. The latter are staged within a virtual environment. Through the planned operation of interaction booths, installed on site and at the premises of the participating in this effort research organisations, this virtual environment will serve as a testing platform for the municipality, the stakeholders, researchers and professionals working in the field to simulate possible urban planning strategies prior to their implementation.

This paper will present the contributions of this research to the creation of a life project (Living Lab) involving the development and post-excavation management of a forgotten historic site. This is achieved by means of a participatory process of designing architectural interventions that aims to reintroduce the site into the everyday life of the contemporary city of Nicosia, and by doing so this approach to urban space rehabilitation contributes to practices of collective identity, social cohesion and inclusion ([3], [4]). The overarching goal of this research is to complement the concept of smart cities with alternative digital methodologies of social sustainability by approaching cultural heritage as a dynamic assemblage of events, activities, performances and identities that relates to space as well as people.

II. URBAN SPACE AS THE MATRIX OF CULTURAL IDENTITIES

The concept of this research revolves around the dynamic relations between historical urban environments and users, identities, communities and their associated memories [5]. The complexity of contemporary cities - even more so in historically layered cities - has grown to unprecedented degree in their history ([6], [7], [8]) while it is acknowledged that there are different ways of studying and approaching their challenges ([9], [10], [11]). Europe has emerged through the successive competition of colonial powers and historical narratives that weaved the complex mosaic of cultures, languages and religions that comprises the region. The pilot project of this research involves one of the gates of the old city of Nicosia, an urban site that lived through severe transformations since medieval times and in particular during the end of the 19th century.

The middle of the 19th century is considered to be a significant starting point in humanities for the establishment of national narratives - emerging in the 18th century, these processes started creating national identities and ethnocentric cultures - and crystallization of borders

among European countries, a historical process that led to two World Wars in the 20th century, which manifested long-standing tensions in the continent. On the other hand, this period was characterized for the creation of common efforts for increasing interconnections between countries and markets and the urbanisation phenomenon of European cities, as result to the Industrial Revolution which created most of large centres across the continent; actually only a few European cities date from the 20th century. These phenomena of modernisation contributed largely to the acceleration of cultural exchanges between nations, while they provoked transformations and blurring of identities in friction, and transferred the existing historical tensions from remote national borders into the city. The process of the territorialisation of this friction generated enclaves of competition within the urban space, the study of the repercussions and effects of which occupy the presented research.

III. THE ROLE OF CULTURAL HERITAGE IN THE SUSTAINABLE DEVELOPMENT OF THE CITY

Today's fracturing of national and cultural identities and boundaries, exacerbated by global economic and political crises, intensifying migrations of people and consequent hostile tensions across borders internationally and within Europe, means that historic cities are facing acute cohesion challenges of physical, sociopolitical and/or cultural division. The integration of existing and opposing cultures, migrants and settlers, is arguably the most pressing challenge Europe is facing in our era. In this context how can we map the relationship between identity, collective memory and spatial experience in the urban environment, with a view to aiding the development of cohesive, inclusive and successful cities? And what is the relation of heritage with the space of the city?

The built environment is punctuated with spatially-expressed resources identified with the territory they occupy, like monuments, squares, parks, streets, markets, museums, landmarks, etc. This research acknowledges that the spatial aspects of heritage include not only historic places associated with culturally-significant people and events, like archaeological sites or finds of important ethnic, national or universal value, but also landscapes, built environments and public spaces, like streets and squares. In a city, culturally-significant sites co-exist with contemporary interventions, and the holistic management of heritage sites' everyday life involves not only their preservation and study, but also their symbiosis with new structures. Thus the study of heritage cannot be separated from its environment.

The affordances of this symbiosis contribute to the sustainable management of the city as a whole due to their impact on the social sustainability of the communities that inhabit the city. All these territories host the performing of everyday, mundane – but occasionally singular and unique – events. The emergent complexity of this terrain, comprised of the assemblage of these territories, stimulates citizens and users of the city during their everyday activities. These stimuli incite a wealth of emotions to the users, while the concurrent

responses to these emotions, their expression or the lack thereof, generate patterns of occupation and spatialised tensions. Occupation and use of resources produces tension due to multiple competing stimuli. The production of these tensions, frictions and pressures that are expressed, and exercised, in the space of the city happens through a continuous process of re-identification.

This is what digital technologies of interaction, data management and communication should focus on if they want to contribute to the social sustainability of the smart city. This research builds upon the widely recognised approach to preserving and promoting the role of cultural heritage as a driver for the sustainable development of the city. Heritage can be used to influence positively the social cohesion of neighbourhoods as it could be promoted in such a way that, instead of provoking tensions and division, it would offer spaces of inclusion, interesting everyday experiences and provide a sense of belonging to socially excluded communities [12]. These capacities of cultural heritage along with opportunities for learning and social interaction, offered to their users by heritage places when these succeed in becoming part of the everyday life of a city - i.e., part of the network of its communal amenities and common resources - contribute also to the well-being and quality of life of the citizens. In this context this research pursues the following inquiries:

- in terms of technique: how to couple reductive models, and computational simulations, with uncertain user behaviour in order to observe unpredictable points of view, or in other words, how to simulate the dynamics of the social aspect of shared historical space?
- in terms of content: how to articulate new interpretations of past practices? and,
- in terms of context (purpose): how to study the role of heritage in the future development of the city and how to further enhance the impact of the former to the latter?

The rest of the paper is occupied with an analysis of the above three thrusts of research inquiry.

IV. SIMULATING THE FUTURE: DIGITAL TECHNOLOGIES OF SIMULATING AGENCY

The presented research explores how technologies like immersive projections and interaction interfaces, movement tracking and body analytics sensors, geo-location, mapping and visualisation tools, 3D documentation, digital reconstruction and computational simulation techniques can be combined in order to enable interdisciplinary studies of the above continuous process of re-identification. These technologies, sourced from architecture, engineering, the gaming industry, ICT and cinema, are important for this study as they enable scholars, researchers - and in general the stakeholders of the city - to observe, explore and ultimately understand the interactions of the stimuli that are actualised in the public space.

This instrumentalised method will hopefully facilitate a more dynamic approach to the study of patterns of occupation, and their respective spatialised tensions, than typical methodologies of ethno-geographic studies and urban analysis [13]. This capacity of the presented tooling is significant as these events are formalised in time. Hence the need for tools and methods capable of dealing with the dynamic conditions of data produced in

time. The presented research pursues this need by means of representation tools that offer real-time immersion opportunities to their user, for the study of staged places, such as monuments of cultural heritage, requires a dynamic understanding of how different events of socialization, identification and urban friction, are influencing each other in time.

Another important aspect of urban space is the social dynamics actualised within it. This transforms it from static space into a dynamic place that in order to be studied requires alternative methods and tools, different to the reductive representations of users via simplified rule-based models and micro-economic based modelling of human behaviour. The tension of urban space is the result of the presence of stimuli and this, in turn, transforms citizens into active users, agents. Within this space, agents act in (sometimes) predictable ways (which can be simulated via stochastic and probabilistic models, e.g., fuzzy logic) but occasionally they respond to stimuli with uncertainty. While these agents respond to non-predetermined, and sometimes inexact stimuli, they also exercise influence in order to pursue their own personal goals. Thus public space, and even more so heritage space, becomes a stage that hosts these conditional performances of subjects with singular behaviours - agents who behave like actors that improvise. How can this capacity for improvisation be offered to the user in simulated environments?

V. STAGING THE PAST: USING COMPUTATIONAL VISUALIZATION AND IMMERSIVE STORYTELLING TECHNIQUES FOR THE STUDY OF SPATIAL IDENTITIES IN THE CITY

Representing tangible and intangible heritage raises questions regarding the recovery of original meaning vs. the critical production of knowledge. Every study of heritage in the built environment is an intervention in the present and thus it is the product of a creative process of the subjective vantage point of the authority (e.g., archaeologist, historian). Distinct from this singular, top-down approach to the representation of history, this research relies on the capacities of digital visualization technologies in engaging users with 'weak' narratives [14]. In his book Rancière [15] suggested that educators should consider equality (in terms of knowing and not knowing) as a starting point rather than a destination. The methodology of the educational component of this research resonates Rancière's concept of the 'ignorant educator', insofar as it is not interested in guiding visitors towards prescribed ends but rather in activating them to explore associated events towards multiple directions, starting from the same 'entry-point'. This framework enables the creation of educational spaces where the user is in the event related to the space, an event that can be new and not a re-enactment of the past and is further analysed elsewhere - as it is beyond the scope of this paper ([16], [17]).

VI. ENABLING THE PRESENT: THE LIFE PROJECT OF THE PAPHOS GATE

The experience of historic urban environments remains an ideal context to probe questions of socioeconomic development and cultural identity. The Eastern Mediterranean preserves

significant examples of cities whose continuous history can be traced all the way back to Prehistory and Antiquity. In particular, the capital of Cyprus, Nicosia, is considered amongst the most contested urban environments having historically layered pasts and perplexing present-day realities in Europe [18]. Between 2013 and 2014 the part of the moat outside the Paphos gate was excavated in an effort led by the Cyprus Department of Antiquities and the Municipality of Nicosia not only to preserve the history of the area and the medieval fortifications, but also to develop and reactivate the neighbourhood. This was an area forgotten and disused during the last couple of decades due to the gradual movement of the commercial and cultural activities away from the old city centre to other parts of Nicosia. The rehabilitation of the historic site of the Paphos gate is co-funded by the EU while the aim of the excavation activity was to unearth and promote the historical continuity of the place from the Middle Ages until today - the gate operated without interruption during the Venetian, Ottoman period and the British rule.

The importance of the site stems from its location, its operation and historical use, its proximity to significant landmarks of the city, as well as its continuous transformation in terms of architectural configuration and built construction through the centuries. Specifically Paphos gate is constructed from parts and building material in secondary use, sourced from other nearby constructions and earlier buildings in the area during medieval times. The site is considered by this research as the locus of a 'thick' slice of the palimpsest of the historic city. First is the devastating presence of the buffer zone running through the site at its thinnest section, like a thread stretched against the medieval walls at the north side of the area, and the Holy Cross Catholic Church of Nicosia, which lies on the buffer zone with each side of the building being accessible from the respective part of the city. Then there is a United Nations station overlooking the site, and also the Kastelliotisa hall, which was used in the past as a female convent and was originally part of the Lusignan palace (13th-14th c.); the Police headquarters built on top of the gate - an addition that changed completely the structure and form of the Paphos gate (Fig. 1[6]); and the carcass of the Spitfire coffee shop (Fig. 1[7]), which was popular among the British soldiers, standing next to the gate reminiscent of the final years of British rule on the island. These are only but a few important elements of the urban environment and historical context of the archaeological site. All these historical moments create a layered aggregate of stimuli, emotions, frictions, pressures and tensions that compile a complex mosaic of heritage identified with so many different conditions, events, communities and stories in the past that can only be approached as shared - as it cannot be identified with any single origin.

In addition to that, the site was chosen as a pilot demonstrator by this research because of its foreseen future role in the network of public spaces of the city. There is ongoing political discussion between the two communities of the island to open the border and create another crossing between the two sides of the divided city - which will operate together with those at Ledra Palace and Ledras street. This forthcoming change will transform the area yet again, which is thus expected to become popular tourist destination. Therefore there is a pressing need for it to be reintegrated in the circulation network of the city. In

this context the development of a post-excavation management plan for the archaeological site, which will be complemented by architectural interventions that will enable it to serve the city, became a priority for the Municipality and the Department of Antiquities. The research team proposed to the stakeholders of the city that this hybrid space should operate between the open-air historic site [19] and the network of public spaces and should not become a controlled archaeological site.

To pursue this strategy, a virtual environment is currently in development that presents a large part of the Greek-Cypriot Nicosia[1] and focuses – by means of a pilot study - on the reconstruction of the Paphos Gate neighbourhood. This reconstruction is produced with the use of archival material and on site documentations via 3D data acquisition (e.g., LiDAR, UAV and terrain Structure-from-Motion techniques). According to the concept of engaging users in 'weak' narrative structures and the use of storytelling, as discussed above, this virtual environment offers exploration opportunities of the associations between the transformation of the monument through the years – from its construction to present day – and the bodily experience of the visitors sojourning in its surrounding area of the city (Fig. 2). As mentioned in the introduction, this paper is occupied with a presentation of the thrust of this research project that regards the opportunities of participation offered to users in the design of the architectural interventions on site. This methodology of engaging the users relies on virtually delivered occasions of interacting with educational events, which are spatially distributed on site, that aim at the re-association of this historical place with the everyday life of the public space.

In this context the presented research thrust aims to create a virtual laboratory of urban exploration that allows the participation of citizens-users in the design and management of the historic site. To do so, the concept of this virtual laboratory is based on the application of design thinking in the process of the post-excavation management of the site. This is pursued by offering to stakeholders of the city opportunities for engaging with the production of the intended interventions through their participation in the designing of the spatial configuration of walking routes in simulated open-air green spaces (Fig. 5; 3).

VII. INTERACTION DESIGN METHODS AND STRATEGIES OF VIRTUAL PARTICIPATION

The application of the concept of gamification [20]; [21] in community design and urban planning, through the use of interactive visualizations of public space, in order to enable participation of local communities - and help individuals that are typically excluded to raise their voice - is an area of design research that is currently attracting significant attention from architects, civic authorities and policy makers [22].

[1] Urban SILENCE (UK), the Cyprus Institute and Wagstaffs Design (UK) were commissioned by the Municipality of Nicosia to develop a 3D interactive platform for the promotion and presentation of newly developed areas of the city along with planned urban regeneration projects (2015).

During the last few years series of initiatives that promote community engagement and facilitate social interaction, like the UN Habitat activities and workshops that are occupied with placemaking, have started experimenting with new dynamic methods of participation that resort to screen-based 2D gameplay. Arguably this approach enables facilitators to collect information from secluded communities, whose interface with governemental support groups and institutions, and therefore their well-being, is challenged by barriers of language and lack of communication, as they are most of the time excluded from public consultation and the relevant discussion.

Fig. 1.[1] Paphos gate, in B&W; [2] Nicosia's Holy Cross Catholic Church, which lies, similarly to the gate, atop the thinnest part of the buffer zone that divides the city; [3] The 'Green Line;' [4] The moat around the walls; [5] the Kastelliotisa hall.

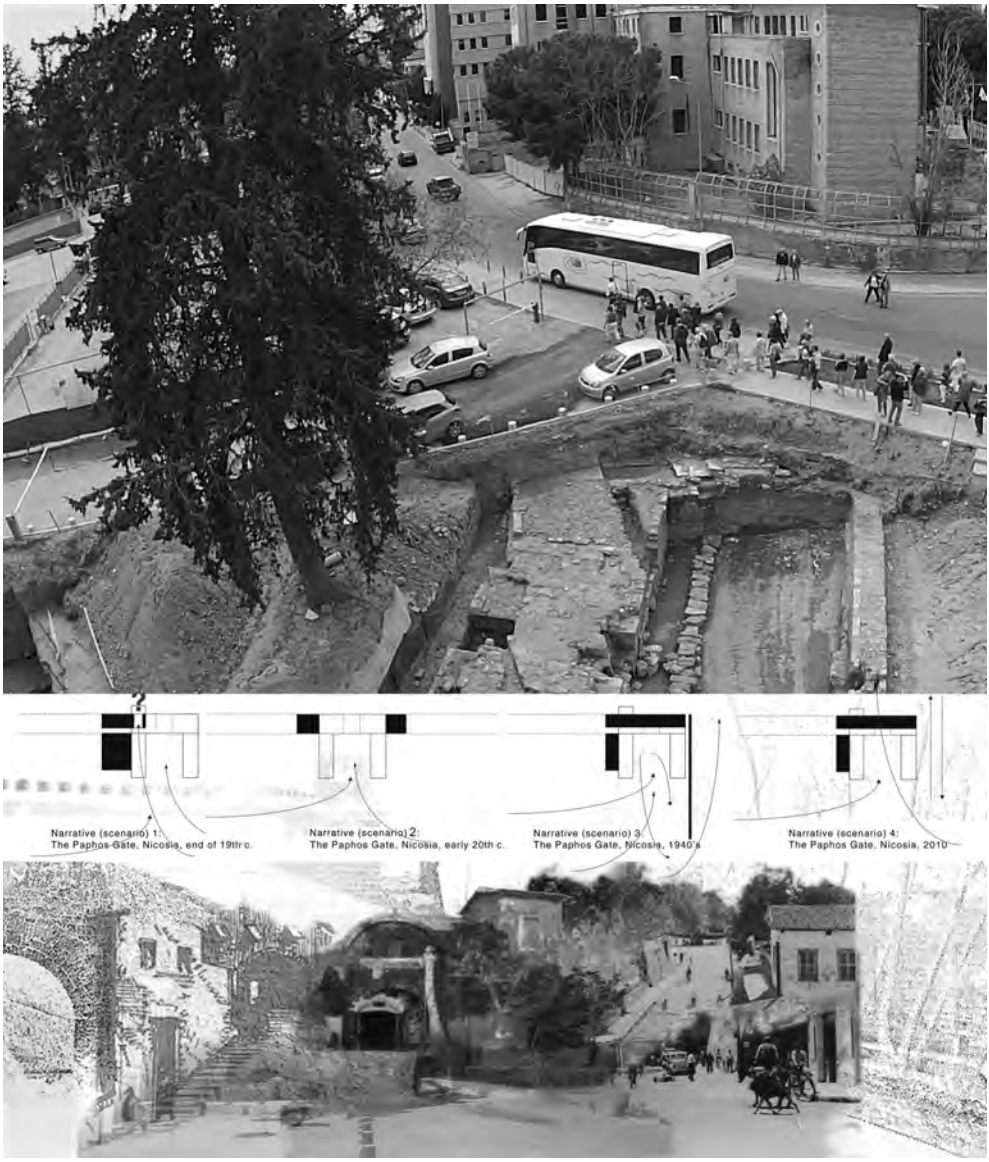

Fig. 2. [top] Photograph from drone footage that shows how the site is degraded and cut off the pedestrian network in the area; [middle] Four historical phases of the Paphos gate, and diagrams of the circulation in and around it; [bottom] The contemporary reality of the studied public space, a popular tourist destination, as formed by the co-existence of parallel 'dimensions' of alternative realities, e.g., a construction complete as it used to be, or as it is planned to become, allows researchers and professionals to experiment, test and explore hidden conditions of the built environment and also invite visitors - citizens and tourists - to learn from past stories, imagine their place in the new conditions presented for the city and immerse themselves in staged places.

Specifically, Pontus Westerberg, Digital Project Manager for UN Habitat highlights the role that the popular online video game *Minecraft* had in enabling a group of fishermen in Haiti, who couldn't read, couldn't write and had never used a computer, to design a plan for Place de la Paix, as it [...] "really let them visualize the changes they wanted to see in that space" [23]. Trying to contribute further to this effort, this paper suggests that when interactivity, and gameplay, is combined with historic narratives, bodily presence and design opportunities, it can offer rich, and articulated, insights to communal viewpoints and local identities that are otherwise difficult to capture verbally.

The presented research contributes to this exploration by extending the above methods of user engagement, which is now pursued through a triptych of techniques, as presented in previous sections of this paper: a) immersive techniques of virtual environments; b) human-computer interfaces for bodily interaction; and, c) spatially-distributed narratives. A wide range of visual interfaces and digital assets, like real-time walkable 3D models, pre-scripted explanatory animations of artefacts' use and operation, weather and vegetation computational simulations – produced with input from bio-archaeologists, dynamic sound-scapes, textual and visual archival material (e.g., maps, drawings and photographs), and more, enrich the visit of the virtual space in order to offer research opportunities and an immersive experience to the user. Exploration of the virtual narratives is facilitated by the storytelling-orientated structure of the interaction system.

Fig. 3. Visualisation of a design scenario proposed for the walking paths that the Department of Antiquities and the Municipality of Nicosia are planning to implement on site.

When the virtual environment is loading for the first time, it presents a list of roles to the user - visualised via the use of avatars - that relate to the historical period s/he wants to visit and it asks for a selection. After the user has identified a role, s/he can start exploring the projected environment at the respective period. This virtual space hosts spatially distributed 'bubbles'/hotspots, which, when s/he moves within any of them, his/her

movement triggers the screening of an explanatory, pre-rendered, cutaway sequence (animation). Introducing 'exploration for learning' incentives and narrative inquiries in virtual space adds a new level of engagement with the tools of spatial analysis and will hopefully contribute to the long standing discussion about new technologies of representation and their role in understanding and constructing built environments [24].

Digital methods of urban analysis have been criticized for not integrating notions of bodily movement into space, since computational environments are often considered to be scale-less and body-less [25], and the present research contributes to overcoming this limitation. It does so by means of the human-computer interface it employs, as the interaction with the visual interfaces and digital assets of the platform occurs through a virtual reality gear that enables body motion tracking, as presented elsewhere [26] (Fig. 4). Most notably the film industry, art scene, gaming industry, storytelling, journalism and healthcare, are currently investing heavily on virtual reality (VR) technologies as they provide a 'good enough' interaction system for the user-interface (UI) that is more ubiquitous and less obtrusive than typical computer interfaces. Following a long line of evolution from I.E. Sutherland's experiments in the 60s[2], VR is again at the forefront of interaction design because of its capacity to provoke emotions of empathy, project virtually any imaginable location and situation and, most importantly, because it can offer to a certain degree the sense of 'presence' to its user.

Fig. 4. Setting up and testing the 1st generation of interaction hardware at the Visualization Lab (at the Cyprus Institute).

This 'exploration for learning' incentive then serves as the vehicle for the research to empower visitors and citizens of the city, as well individuals and communities that may

[2] Cf. Sutherland's The Ultimate Display, a head-mounted three-dimensional display (Sutherland, I.E., 1965. The Ultimate Display. Proceedings of IFIP Congress, 2, pp.506–8).

be excluded, by enabling them to raise their voice and participate in the future development of the public space via a dynamic method of registering and documenting personal choices and tolerances. This becomes possible through the 'virtual world creator' feature of the platform. The virtual platform allows users to choose, sketch, follow and virtually explore paths and routes inside the projected space in order to offer their personal account of how the specific public space should operate and consolidate their understanding of the complex urban space. The real-time exploration of a projected space extends the participants' experience of street walking into a journey of exploration, discovery and understanding spatial relations.

Fig. 5. The interface involves a mobile app for the sketching of proposed routes in and around the historic site by users. These routes are then created in the virtual environment in order for their 'designers' and others to assess them and express their opinions (©Colter Wehmeier).

VIII. CONCLUSIONS AND BEGINNINGS

Recognizing the body of work produced by CASA Centre (the Bartlett, UCL) and the application of Space Syntax for the study of the complexities of urban space, the vision of this research is to develop a digital platform which through immersion, cinematic language and creative opportunities offered through participation in the design of public infrastructure in the city will contribute to the reactivation of forgotten open air spaces that used to be popular landmarks within the urban fabric of European cities. In the case of the presented pilot project, the Municipality of Nicosia and the Cyprus Department of Antiquities are supporting this effort (Fig. 6), and they are currently planning the construction of the proposed walking paths, along with the installation of VR-enabled interaction devices, in the archaeological site of the Paphos gate.

Fig. 6. An early result of the collaboration with the Department of Antiquities and the Municipality of Nicosia is the installation of light projectors that project some of the inscriptions found on site onto the walls of the tunnel of the gate in order to enable passers-by to see them.

The methodology presented enables the observation and assessment of the successful integration of the heritage site in the urban fabric through a number of recorded indicators, like the degree of information transmission and the successful communication of content, the accessibility of the site and its clear linkages with the rest of the circulation network of the city – e.g., both visual and physical connections, the image of the place, the relevance of the activities planned to take place on site, as well as, whether users recall personal accounts of events that happened on the site, and document associated memories. Data collection involves not only questionnaires but mostly tracking movement information, voice recordings and assessment of the proposed routes and paths across the site [27]. Positively assessed spaces would justify a sense of connection with the place and would therefore highlight the significance of that simulated space for the social sustainability of the neighbourhood. Community participation in planning is important for sustainable cities and this research is an example of how heritage can complement current 'smart' retrofit policies and contribute to the holistic development of historic cities.

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Determination of electromagnetic field exposure in public spaces

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Abstract – *The monitoring of electromagnetic (EM) field, caused by the presence of radio frequency (RF) and microwave radiation from ICT devices as various sources of EM field, has emerged as an important technical and social challenge in terms of planning, management and usage of open public spaces. Considering the necessity of EM field level determination in the context of using ICT devices in service areas, as well as monitoring of EM field exposure in public spaces, the several technical issues have been foreseen in the analyses based on corresponding examples: from the method for modelling of EM field propagation in the vicinity of RF and microwave sources - base stations for mobile networks, broadcasting transmitters, local wireless networks, together with the distribution of EM field from ICT devices, through the appropriate measurement and exposure assessment methods, to the adequate software support for geo-visualisation, the data acquisition and processing.*

Keywords— public spaces; electromagnetic field exposure, mobile communication, base station

I. INTRODUCTION

Along with the growth of services and products used in modern information technology applications, wireless communication systems have become an essential part of everyday life. The rapid development of wireless communication technologies using radiofrequencies (RF) have induced a substantial increase in numerous electromagnetic field (EMF) sources, which can be divided in two main categories: fixed ambient sources, such as radio/TV broadcast transmitters or mobile phone base stations, and portable personal sources, such as mobile phones and other terminals used for wireless communication. The majority of the world's population is using mobile phones in urban environments. The worldwide use of mobile telephony has increased considerably with the development of the digital technologies over the past 20 years. The penetration of the mobile phone is beyond 100% in almost all European countries implying that Europe leads in mobile penetration worldwide. The increased use of mobile phones has led to an increased deployment of base stations, the number of which depends on several factors such as the number of network providers, number of users, number of simultaneous calls, etc. The base stations are often situated close to public spaces and become the cause for concerns of human exposure ([1], [2]).

In most public spaces visitors also use mobile phones and other portable devices for the purpose of communication, but most people are not aware of the health implication and possible safety measures.

In general, the data most widely available on exposure of the public to radiofrequency (RF) electromagnetic field (EMF) within the microwave range of spectrum (300 MHz–300 GHz) relates to technology for mobile telecommunications – GSM (Global System for Mobile Communication) and UMTS (Universal Mobile Telecommunication System), coexisting with another technology occupying the microwave spectrum, such as radio and television broadcasting, RF identification system and wireless communications applications: WiFi, WLAN (Wireless Local Area Network) and WiMax (Worldwide Interoperability for Microwave Access). The newest generation of mobile telecommunications networks – LTE (Long Term Evolution) also represents a growing source of RF EMF exposure. Due to the omnipresence of mobile phone base stations and mobile phone handsets, this technology dominates the exposure in the outdoor urban environments [1,2].

The fast changing world of information technologies and particularly mobile telecommunications has raised concern over possible health effects from exposure to EMF radiated from cellular base stations and mobile phone handsets. Therefore the people in public spaces situated in the vicinity of base stations are now asking questions today, regarding EMF exposure in comparison to the acceptable level and avoiding potential adverse health effects. This paper will try to summarise these questions, starting with basic concepts of electromagnetics and theoretical background of EMF radiation, in terms of exposure metrics and standards. Taking into account previously published papers and scientific literature, this paper reviews the estimation and evaluation of the EMF exposure in public spaces using a different methodology based on measurements and modelling. In order to illustrate the determination of radiated EMF from cellular base stations which aim to verify the exposure compliance with human protection guidelines, measured results of electric field level in frequency ranges of mobile communication systems are presented.

II. EMF EXPOSURE

A. Basic theory of Electromagnetic radiation

The range of frequencies that are found within the band 3 kHz to 300 GHz (called radio frequencies) are used in various applications that require radio waves - radio and television broadcasting, radar and microwave systems and cellular mobile communication. Generally, radio waves propagated by an antenna in free space are called electromagnetic (EM) waves [3], that may have diverse energy levels transmitted from a source; this is generally known as EM radiation. The EM radiation is a form of energy exhibiting wave-like behavior as it travels through space. It has both electric and magnetic field components, which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation. When referring to biological radiation exposures, EM radiation is divided into

two types: ionising and non-ionising. Since the human body is composed of about 60 percent water, different types of radiations refer to whether the RF energy is high enough to break chemical bonds of water (ionising) or not (non-ionising). The ionising radiation affects the human organs to greater extent, while the non-ionising radiation does not alter the atomic structure of creatures, but still affects the human cells and may create negative health effects [4].

Figure 1 shows a graphical representation of the spectrum of EM energy or radiation, together with the application area of corresponding frequency range. For telecommunication purposes, EMF between a few MHz to some GHz are of particular interest, where numerous mobile telephony systems can be found in addition to broadcasting sources and commercial radio systems.

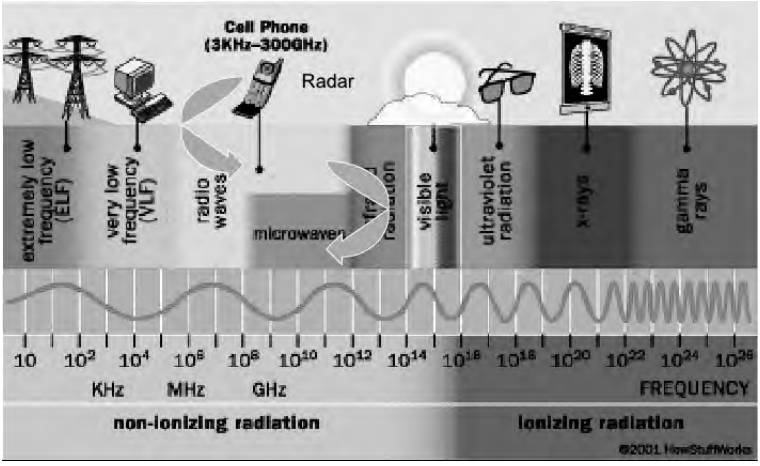

Fig. 1. Spectrum of EM radiation (http://www.astrosurf.com/luxorion/)

Mobile phones communicate by radio signals passing between the phone and the base station antennas. Mobile telephones are connected to the base station by two separate radio links: the uplink from phone to base station – in frequency ranges 880–915, 1710–1785, 1920–1980 MHz, and the downlink from the base station to phone – related to ranges 925–960, 1805–1880, 2110–2170 MHz, for GSM 900, GSM 1800 and UMTS 2100, respectively. The base station antenna transmits in the frequency range that is divided into sub-bands, which are allocated to various operators. There may be several carrier frequencies allotted to one operator, where each carrier frequency may transmit 10 to 20W of power. Taking into account that there may be 3-4 operators on the same rooftop or tower, thereby the total transmitted power may achieve the order of 100W of power. In addition, directional antennas with a typical gain of 10-20 dB (numeric value is 10-100) are used, and therefore several KW of power may be transmitted effectively, in the main beam direction.

In general, the distribution of EMF is temporally and spatially highly variable [5]. There are a variety of reasons for variations in the transmitted power at any given time: how many channels are in use, how many of the time slots in the traffic channels are used, and whether a function that deactivates the transmission if there is no voice detected is used or not. Accordingly, the emitted power from a base station may vary over the day and week from a minimal power of e.g. 10 W during times with low to modest traffic, to up to several times that level at peak traffic. Any attempt to characterise the exposure around a base station should take this traffic-dependent time-variation into account. Information from the operator of the base station on traffic statistics could provide a basis on how this should be done. Options could include sampling (for an average situation) and/or choosing a probable maximum traffic time (for the worst case situation).

Besides emission variations with time, EMF radiation varies with distance from the base station. There are different types of antennas regarding directionality. Omni antennas radiate in every direction (seen horizontally), while sector antennas effectively only radiate in a sector. In order to permit increased re-use of frequencies, as well as reduced interference, most base stations in high traffic density areas, such as cities, are of the sector type. As previously mentioned, the preferred sector antenna gain is between 10 and 20 dB meaning that the emitted power may be between 10 - 100 times stronger in the intended directions compared to an omni antenna, while it will be correspondingly weaker in other directions [3]. For example, the exposure behind a sector antenna could be 300 times weaker than in the main lobe. In addition to this horizontal directionality, the antenna lobe will also have a strong vertical directionality, with a fairly narrow beam, which is often tilted slightly downward.

B. Metrics for EMF exposure

This section gives an overview of current metrics for evaluating radio-frequency (RF) electromagnetic field (EMF) exposure in the frequency range of the microwave spectrum: the most often used quantities and their usage.

International guidelines limit the levels of quantities to protect people against adverse health effects from exposure to EMF. Basic measures to protect people from exposure to EMF are independently defined for the base station and for the personal mobile devices. In the frequency range of our interest, several quantities are used to express exposure: incident field levels (E and H), incident power density (S) and specific absorption rate in the human body (SAR) are the most common quantities.

The exposure to incident radio-frequency EMF is assessed in terms of power density, electric field and magnetic field. In the far-field of a source, the power density, electric field and the magnetic field are related through the characteristic impedance in free space:

$$S = E_{rms}^2 / Z_0 = Z_0 H_{rms}^2 \qquad (1)$$

with Z_0 the characteristic impedance in free space (377ohm), E_{rms} the root-mean-squared (RMS) electric field (V/m) and H_{rms} the RMS magnetic field (A/m).

The far-field region can be expected at a distance $2D^2/\lambda$, where D is the largest dimension of the antenna, and λ is the wavelength. In this region, the source can be approximated as a point, suggesting that the power density S (W/m^2) for an isotropic antenna, and in the absence of any interfering objects, will decrease as $1/r^2$, where r is distance from antenna.

In the close vicinity of base stations, calculations are more difficult because of the so-called near-field conditions. In this region, the relationships between the electric and the magnetic fields are much more complex and separate evaluation of them should be performed. Calculations have indicated that using the far-field approximation at, say, 10 m from a large base station antenna would overestimate the exposure by a few percentage, while at 1 m the overestimate would be some 10-20 times. Accordingly, from a practical point of view, beyond a distance of about 10 m from the base station antenna, far-field based calculations are suitable for determining and surveying the EMF exposures.

In the near-field, at distances somewhat smaller than one wavelength (usually less than 10 cm from a mobile telephony source), there is a dynamic energy interaction between the source and the human body. As a consequence, instead of field strengths other methods of evaluations must be used. The SAR (Specific Absorption Rate) is a measure for the induced EMF inside the human body, which is defined as:

$$SAR = \sigma E_{rms}^2/\rho \qquad (2)$$

with σ the conductivity (S/m) and ρ the mass density (kg/m^3).

Besides, new quantities are defined in scientific literature, such as dose and exposure ratios, to determine realistic exposure of people to EMF. Generally, the nature of EMF (frequency, intensity, duration of exposure) offers a large variety of quantities which can be used as exposure metrics [6]. Moreover, a wide range of exposure conditions can exist: individual or multiple source exposure, near or far-field exposure, short- or long-term exposure. So far, multiple methods to assess the exposure are present in the epidemiological literature. In case of multiple-source exposure, other metrics can be defined, based on the contribution of each source to the total exposure. Guidelines and standards defined ratios to evaluate compliance in the case of simultaneous exposure to fields of different frequencies. Other definitions provide exposure ratio metrics, like the average contribution (AC), and the maximal contribution (MC) of different sources to the total exposure value.

C. Standards and recommendation for exposure limits

In any particular exposure situation, measured or calculated values of quantities like field levels (electric/magnetic field intensity), power density and specific absorption rate (SAR), can be compared with the appropriate reference level. If the measured or calculated value exceeds the reference level, it is necessary to test compliance with the relevant field quantity and to determine whether additional protective measures are necessary. In this section, the derived limits and reference levels of different international and national standards, regulations and other documents are presented, with the main focus on the limits in the frequency range around 900 MHz and 1800 MHz and 2100 MHz to cover exposure next to base stations.

The International Commission for Non-Ionizing Radiation Protection (ICNIRP) formulated guidelines on exposure limits for EMF, based on health effects resulting from absorption of energy during exposure to EMF between 100 kHz and 300 GHz [7]. The European Union published recommendations to limit the exposure of the general public in EMF [8] that rely on the ICNIRP guidelines and are therefore based on scientific appraisal of risk-related data. Some countries have established similar national laws, regulations, guidelines or standards for exposure to RF fields, while others have adopted the ICNIRP guidelines.

In general, international documents of this type are those of ICNIRP, IEEE and CENELEC [9], as well as national guidelines from Austria (ÖNORM 1992), the UK (NRPB, 1993) and the Netherlands (NEL, 1997), and are based on the concept of avoiding the established short-term health effects of exposure. In some countries regulations were adopted containing exposure limits far below the ICNIRP recommendations (Hungary, 1986; Italy, 1998; Austria - SvorGW, 1998; Switzerland - NISV, 1999), which are generally based on precautionary concepts strongly depending on social and political arguments in addition to scientific considerations. Generally, the public limits of the documents for the electric field strengths are given for frequency between 0.1 MHz and 300 GHz. However, in order to better compare the limits in the frequency bands of mobile systems a more detailed overview on the limits of the mentioned documents is given for the frequency range 100 MHz to 10 GHz in Figure 2. As seen in Figure 2, there is a frequency variation in these levels in some guidelines. Considering operating frequencies for cellular systems, the limits of the electric field strength of considered documents at 900 MHz vary between 0.6 and 112.5 V/m (corresponding to a range of 0.001 to 33 W/m^2 for power density limits), while at 1800 MHz, the range is from 0.6 to 194 V/m (0.001 to 100 W/m^2). As an illustration, numerical values of the electric field strength and power density limits defined by international guidelines ICNIRP and IEEE, at 900 MHz, 1800 MHz and 2100 MHz are given in Table I.

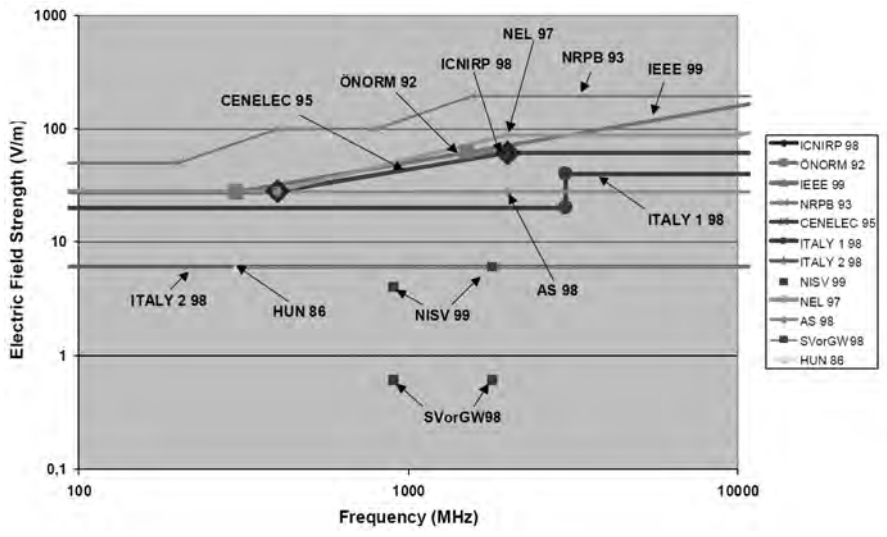

Fig. 2. Comparison of limits for radiofrequency fields

TABLE I. REFERENCE LEVELS FOR EXPOSURE AT 900 AND 1800 MHZ

Limits at frequency	Reference levels for the general public		
	International standard	*Electric field (V/m)*	*Power density (W/m2)*
900 MHz	ICNIRP	41.25	4.50
	IEEE	47.60	6.00
1800 MHz	ICNIRP	58.30	9.00
	IEEE	67.30	12.00
2100 MHz	ICNIRP	61.00	10.00
	IEEE	71.00	13.50

III. EMF DETERMINATION AND MONITORING

A. Numerical modelling of EMF exposure

The numerical investigation of the EMF exposure is limited. The three-dimensional (3D) ray-tracing tools are used to predict the exposure in a certain area during the network design stage. In the near-field of antennas, such as base station antennas, 3D electromagnetic solvers are employed to investigate the incident exposure. Simulations provide detailed information of the field distribution around and inside the body, but numerical tools have the drawback of always being an approximation of the real world and often require long runtimes and a large amount of processing power.

Different geospatial propagation models have been developed to compute environmental EMF exposure from fixed site transmitters (mobile phone base stations and broadcast transmitters), considering the three dimensional environment by including topography and buildings in the model computations [10]. The model calculation is generally based on a data of transmitters (position, transmission direction, antenna types and radiation pattern, transmitter power and number of channels) and a 3D building model of the study area, considering, for example, shielding and diffraction by buildings and topography [4]. Furthermore, detailed information about the transmitters, such as antenna pattern and vertical tilt, may also be taken into account. In general, three main model inputs are antenna data, 3D building geometry and a digital terrain model, together with detailed information of all cell antennas from the mobile phone network operators: coordinates, height, horizontal direction, vertical tilt, antenna type, frequency, start date of operation and output power of each antenna [11]. The models usually compute the field strengths of different frequency bands, corresponding to different exposure sources, such as GSM900, GSM1800 and UMTS2100. The models are based on different radio wave propagation algorithms to estimate EMF exposure, such as the COST–Walfisch–Ikegami model [12] and models developed by the International Telecommunications Union (ITU), for example the ITU-R P.1546-1 [13] or principles described in ITU-R P.1411 [14].

B. EMF exposure measurement

The exposure to incident EMF is mainly assessed by measurements, usually by using broadband and/or frequency selective equipment. Generally, two types of measurement procedures have been applied for EMF exposure determination: fixed-location and mobile monitoring. Fixed-location measurements with a spectrum analyser are very accurate for determination of exposure at a specific point in time and space. The signal to the spectrum analyser is expressed in electric field strengths (in V/m) using instrument design parameters such as antenna factor and cable loss. For practical purposes, the results are often given in decibels, where e.g. dBV/m = 10logV/m. Due to high spatial variation of EMF around base stations, this type of exposure monitoring is time and resource intensive in terms of equipment, costs and trained personnel ([2], [15]). On the other hand, portable exposure meters (PEMs) are more convenient for collecting data representing typical exposure levels over time in a wide geographic area. Therefore, despite some limitations [2] such devices have been applied for collecting numerous measurements with relative little effort at different locations ([4], [16], [17], [18], [19], [20]).

In the last 20 years exposure measurement campaigns were performed in all European countries by systematic planning processes and also on request of the public or local authorities [1]. Most of them were focused on the exposure to RF of mobile phone base stations. Regarding some samples of data by countries, the locations near the base stations and sensitive places (green zones parks, hospitals or schools) were investigated. For example, in Germany within the campaign in 1997, the maximum measured RF power densities were 0,04 W/m² while the mean value was 0,0052 W/m² [21]. In Spain, the maximum power density obtained by measurement that was achieved was 0,0118 W/m², which is quite small compared to the limits (4,5 W/m²). In a Spanish case study the medium power density in outdoor urban area showed 0,000082 W/m². In Italy innovative communication actions were combined with a measurement campaign. The action was introduced in 2003 where a mobile EMF laboratory called "BluBus" and later "BluShuttle" cars were moving across the country equipped with a wideband portable RF field meter and an autonomous control centre. According to the summary of these measurements more than 88% of recorded electric field strength was below 1 V/m, 8,1% between 1-3 V/m, 2,6% between 3-6 V/m and less than 0,3% above 6 V/m. Within a large measurement campaign in France more than 20,000 site measurements have been carried out by ANFR (Agence Nationale des Fréquences) since 2001. More than 60% of measured total field was below 1V/m, less than 0,1% above 20 V/m and around 2,8% between 6 V/m and 20 V/m. The main focus of campaign elaborated in three countries, Belgium, Netherlands and Sweden between 2009 September and 2010 April, was to measure the environmental exposure. The maximal total field was 3,9 V/m in a residential environment mainly due to the GSM900 signal.

Many countries upload their measurement results on the Internet and/or publish the data annually. A comparative analysis of the results of EMF measurements in the EU indicated

that mean electric field strengths were between 0.08 V/m and 1.8 V/m. In summary, the general results of European site measurement surveys showed that more than 60% of measured total EMF exposure was below 1 V/m (~0,003 W/m2), less than 1% above 6 V/m (0,095 W/m^2) and only less than 0,1% was above 20 V/m (1 W/m^2) field strength (power density). The relevant recommended exposure limit for the public is in the range of 40-60 V/m (4-10 W/m^2). The absorbed power in the human body is related to the power density in free space. No exposure data above the public exposure limit was obtained from these surveys.

C. EMF exposure from mobile phones

Cellular phones are specific EMF sources, since they are used in close vicinity of the head: either on the ear or in front of the face. The exposure to EMF emitted by mobile phone handsets is determined as values of the specific absorption rate (SAR). Exposure evaluation can be based either on dedicated measurements or on numerical modelling.

The field strength and distribution of SAR within the head are dependent on the phone design and the communication system. It is important to emphasise that at a distance of 10 cm from the mobile phone the absorbed power in the head decreases more than 10 times compared to when assessed close to the ear. At 40 cm in front of the head the maximum SAR over 10g is close to 1% of the SAR touching the phone to the head.

During normal use of mobile phones with maximum output powers of 1 to 2 W, the localised SAR is less than 2 W/kg [22]. Estimating the cumulative exposure, about 30 min of mobile phone use corresponds to a 1-day exposure from far field source at an incident level of 1–2 V/m [23]. However the EU limit of permissible SAR in the head is 2 W/kg; the real life exposure to RF fields from mobile devices is less than the results of compliance tests.

In general, new phone models with higher frequencies emit less power than older types, and since the year 2001 the mobile phone manufactures have been required to notify the SAR levels of their new phone models. The mobile phones also control the transmitted power according to the network coverage. The better the network coverage, the less transmitted power of a cellular phone is needed to communicate with the base station. According to the exposure assessment of epidemiological studies and the information from the operators, the phones in GSM mode work 30-50% of their time in maximum power, while in 3G mode only 1% of their time.

The number of calls and duration of calls can be a sufficient parameter to estimate the cumulative power emitted by the handset of a cellular telephone. According to the Swiss QUALIFEX study the average mobile phone call time of the participants was 25,6 minutes per week. The average output power was 133 mW for GSM 900 mobile phone, 62,2 mW for GSM 1800 and 650 μ W for UMTS phone [4].

Using mobile phones to transmit data may increase power levels up to three times higher than those transmitted in speaking mode. In these cases the mobile phone is usually further

away from the body. In addition, the use of a hands-free device and even a small distance to the body reduces the exposure of the phone user.

IV. RESULTS

In order to illustrate measurements applied for EMF exposure determination using spectrum analyser NARDA SRM-3000, Figure 3 shows corresponding results of electric field levels in bands related to GSM900, GSM 1800 and UMTS, respectively. From the experiment we found that the maximum value of electric field (less than 90 dBμV/m corresponding with 1V/m) radiated from base station antenna does not exceed ICNIRP levels. However, it is important to note that the threshold limits defined by the ICNIRP are considered to be rather too generous and therefore it becomes the subject matter of public interest in the context of possible environmental adverse effects.

V. CONCLUSION

We considered different aspects of EMF exposure from cellular base station, as well as mobile devices, including a comparison of measured results of EMF level with reference ones defined by international standards.

The levels of EMF exposure radiated from fixed outdoor body far-fixed sources of wireless telecommunication systems, such as mobile base stations (GSM, 3G, LTE) vary in space and time. The most characteristic exposure units are the electric and magnetic field strength, as well as power density. The exposure is continuous and maximum exposure levels are significantly below the recommended European exposure limits (typically less than 1 V/m). This category of EMF exposure has importance for risk analysis in terms of investigations of long-term changes of exposure to RF of population in public spaces.

The exposure levels from the mobile phones and wireless body-close portable devices are highly variable and local. The most characteristic of this exposure unit is the SAR (W/kg). The levels of exposure from mobile handsets (GSM, 3G) are below the recommended European exposure limit (2 W/kg), but the local maximum may be close to the limit.

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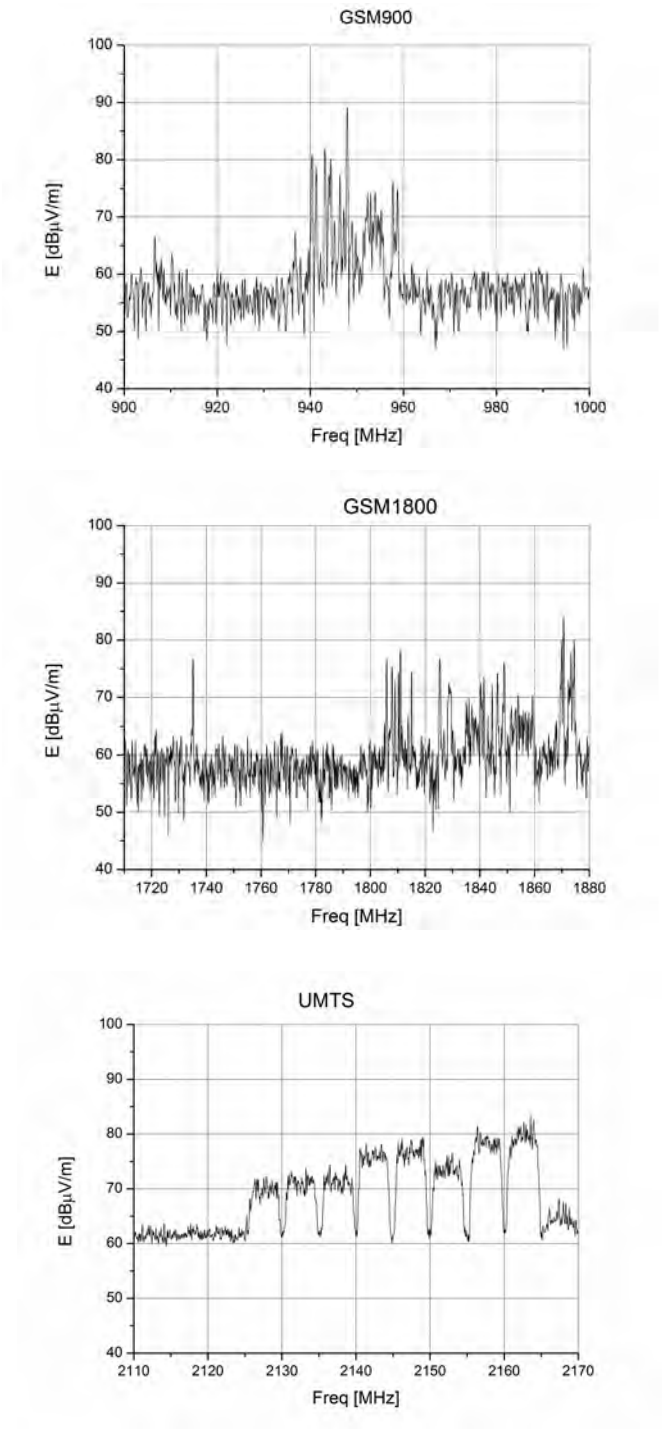

Fig. 3. Measured results of EMF level for GSM 900, GSM 1800 and UMTS

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Digital methods and social practices in public space – some salient themes

Gabriela Maksymiuk

A number of the above papers portray a useful 'state of affairs' with the use of digital technologies in enhancing spatial experience, in understanding users' behaviour or even in empowering citizens to (virtually) learn more about urban spaces (such as historical spaces that do not exist anymore). Some papers further raise a number of new, important, questions, including ones of an ethical nature, particularly with regard to the extent to which new technology may be used in monitoring the activities of other individuals. The papers reveal a clear *leitmotif* running throughout the entire track, namely, the duality of the challenge we are facing, as we deal with two main types of questions:

(a) the 'how' questions, addressed to technology – such as, how to collect and visualise data, how to encourage people to share information and ideas and how to develop the most appropriate and effective tools to address specific research questions and provide people with additional knowledge; and
(b) the 'why' questions, related to social practices of public space users – such as why users behave in a specific manner, why do we want individuals to participate and why do we want to have this data that is being collected by the above-mentioned tools.

In the conference discussion that ensued, speakers emphasised the need to first understand, or even define, the link between technology and social practices of users. If we understand why we need particular information, it would be easier to design or further develop the technology for it. Speakers also raised the issue that different tools / methodologies bring different data. So the more fundamental research question must centre on what appropriate methodologies one should use, particularly so as to create tools that enable one to obtain unbiased and objective results. The discussion developed into the need to merge quantitative and qualitative research methods, and the utility of more traditional methods that may complement the new technologies in learning about people and space.

The final session addressed the issue of how this newly gained knowledge regarding social practices may inform planning decisions, not as means of feeding this data, obtained from people, for top-down decision-making, but rather using the data to allow people to be empowered in the design and planning processes in a bottom-up manner. In order to enable this to happen, the role of the spatial planner and designer must be rethought as being more of a facilitator who may translate this data in a manner that may be easily interpreted by the citizens so as to truly make a positive contribution to their quality of life.

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PART II
ETHNOGRAPHIC CHALLENGES AND THE CREATION OF DIGITALLY MEDIATED URBAN SPACES

Behaviour, expectations and preferences of 'digital natives' in regard to the design of urban public spaces

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Gabriela Maksymiuk
Kinga Kimic
Natalia Kołodyńska

Abstract – *The possibility of ICT applications in designing outdoor public spaces is essential. In order to enhance a healthy lifestyle and bring people outdoors, it is crucial to study the behaviour of ICT users and understand their expectations related to attractive public spaces. Currently in Poland, Wi-Fi technology is widespread, mainly in buildings, and outdoor hot-spots are still rather an exception.*

The research results let us identify 4 main groups of Wi-Fi users characterised by different activities performed in urban spaces: focused on work; focused on entertainment; transit pedestrians; or, tourists. For each user group studied, its preferences, needs and expectations in regard to successful and attractive public open spaces were identified. The research results enable further elaboration of design guidelines and principles for modern outdoor ICT - friendly public space, e.g. a cyber park.

Keywords: urban ethnography, green spaces, ICT, society, city.

I. INTRODUCTION

Modern life, for the majority of urban citizens, revolves around the features of civilization, but it is also linked with negative effects, such as less contact with nature. Current realities and societal expectations impose on people a new way of working, with new leisure activities and lifestyles. One of the determinants of a changing society is omnipresent: over the past two decades a new generation of 'digital natives' has emerged - people who feel safe only in environments dominated by electronics ([1], [2]), or in other words a generation of tech-savvy young people immersed in digital technologies [3]. We might assume that those young people might avoid spending time outdoors. At the same time, more attention is placed on environment protection issues and, on the other hand, physical, direct contact with nature is less frequently achieved by citizens. It might be summarised that, we experience 'times of fear of nature' [4]. Nevertheless, in general, people are social beings and they tend to meet each other. Presently, in urban agglomerations, it is difficult to start a spontaneous conversation with a stranger as citizens are constantly busy and public spaces resemble more 'spaces of flow' than places for social gatherings. People seek contact with others and they need a foothold that could help them to initiate such contact. The architecture and built environment in many cities is insufficient in terms of creating

a space for social interactions. These contacts require something more than just a building or a square, but a well-designed public space that enhances conversations and direct contact, for example, is needed. The proper design of public pro-social space can promote and invite interactions [5].

According to Gehl [5] there are three types of activities that take place outdoors: 1) necessary activities, 2) optional activities and 3) social ones. The necessary activities do not depend on the quality of space or physical conditions, as they must be realised anyway, e.g. shopping, commuting to the office or school, etc. These activities are cyclical and arbitrarily enforced, whereas the optional activities are freely chosen by users. Thus, they are determined by the quality of space and depend on weather conditions, time of day, etc. These actions include recreation, rest and reading. Last, but not least, the type of activity, which might be described as an outcome of the two previously mentioned, is known as social activity. This group includes conversations, social contacts and spending time together. These activities depend mostly on the physical conditions and weather. For the proper functioning of public space it is necessary to design it in a way that allows users to perform optional and social activities most frequently. These activities should happen naturally and freely.

The design decisions can affect people's behaviour, creating positive or negative conditions to stay outdoors. The right planning and design decisions create a vibrant city. There is a close relationship between the quality of urban space and the activity of the citizens. The more time people spend outdoors, the more interactions occur, and people consider the environment to be more friendly [6]. People prefer to stay in groups, they mutually attract and stimulate each other. The possibility of getting together, listening, observing, etc., provides an opportunity for contact with others, such as starting a chat, studying social life, enrichment of public life, gaining experience and inspirations [7].

However, the mobile Internet users create a specific social group, and while being in public spaces they choose the sites rarely visited to ensure their privacy. The observations performed by Hampton, Livio and Sessions [8] suggest that people avoid the crowd in general, and 40% of them choose a place, which is emptier than the surroundings, while 50% prefer places with similar density, and only 10% chose sites, where there are more people than average. Very rarely they use the places where there is nobody present. In public spaces, for the 'digital natives' users, the virtual contacts are more important than the real ones [8]. Moreover, possessing a mobile device, and using it, creates a kind of 'bubble', which is a means of protection against the unwanted social interactions or relationships. At the same time, for other pedestrians or users of public space, the mobile Internet users are perceived as unapproachable and reluctant to establish contacts. The existing stereotype is that the typical mobile Internet user is a young, single, educated man. Studies show that about 70% of people using the hot spots are those who are not in relationships, or do not live with a partner. Therefore, 80% of users usually come alone and make an impression of a lack of interest in the activities of others. When it comes to motivation for why people choose to use the hotspots, it appears that they need a change in a working habitat, or

are pressed for time and need to find the necessary information while being outside in public spaces [9].

This paper presents the selected results of a broader study on guidelines for the organisation and design of hotspots surrounding green spaces, performed in 2015. The aim of the study was twofold. First, to identify the behaviours of wireless Internet users in public spaces and, secondly, to examine their expectations and preferences in regard to the organisation of public spaces that enable the use of new technologies in open areas.

II. MATERIALS AND METHODS

The performed research included 3 stages: 1) passive observations of Wi-Fi users in urban public spaces (both indoor and outdoor), 2) individual interviews with selected users, and 3) an anonymous on-line surveys aimed at understanding their preferences. Additionally, the research was complemented by a survey among suppliers of mobile Internet.

The passive observations were conducted in three Polish cities - Gdańsk, Katowice and Warsaw. In order to study behaviour of Wi-FI users in various settings, four different hotspot surroundings were selected. The Wi-Fi users were observed in:

1) outdoor hotspots located in open public spaces, without the possibility of comfortable use, i.e. bus station, city main square and streets,
2) outdoor hotspots located in open public spaces, with the possibility of comfortable use, i.e. urban parks,
3) indoor hotspots with free Wi-Fi Internet access in a commercial building, i.e. cafe in a downtown area
4) indoor hotspots with free Wi-Fi Internet access located in a commercial building, i.e. a shopping mall.

Places of observations were selected in a way that allowed for the most effective examination of the phenomenon of the use of hotspots. Moreover, the hotspot locations in different cities were comparable to each other in terms of distance from the city centre, popularity of location, function, or free public access. Table 1 summarises the characteristics of locations, where the passive observations have been carried out. Each location has been visited twice and the overall time spent for the passive observations has been 24 hours.

The second phase of the research included individual interviews with selected users. This stage was designed as a transition between the passive observations and actual anonymous on-line survey. The individual in-depth interviews allowed users to freely express their opinion on hotspots, and on the other hand, they helped us to understand the users' motivations and to explain some of their behaviours. The research sample was 20 interviewees. The responses of the users were varied and it was difficult to group them into homogeneous outcomes, that is why they will not be presented in this paper further. However, those replies allowed us to have a broader look at the problem and were used as a base for the on-line questionnaire construction, which was the main research tool applied.

TABLE I. CHARACTERISTICS OF VARIOUS HOTSPOTS SETTINGS

No.	1	2	3	4
Type of hotspot	An outdoor hotspot located in open public spaces, without the possibility of comfortable use	An outdoor hotspot located in open public spaces, with the possibility of comfortable use	An indoor hotspot with free Wi-Fi Internet access in a cafe	An indoor hotspot with free Wi-Fi Internet access in a shopping mall
Hotspot's characteristics	• an open public space, equipped with a signal transmitter, but without any recreational equipment • very few benches or no benches at all • noisy surroundings • heavy car and pedestrian traffic	• an open public space, equipped with a signal transmitter • urban furniture enabling rest, e.g. benches and seats • in a quiet environment with moderate car and pedestrian traffic	• an indoor space equipped with a signal transmitter • with the possibility for rest, work or refreshment (food and drinks available) • comfortable furniture and interior design • free access to charging (electric sockets) • quiet atmosphere	• an indoor space equipped with a signal transmitter • free access to charging (electric sockets) • crowded and noisy place

The on-line survey was the next step following the passive observations and individual interviews. The survey was aimed at authentication of previously collected data and also as a further study of expectations of a wider Wi-Fi users group. The questions dealt with present ways of Internet usage, both indoors and outdoors. Besides, the users were also asked about their preferences in terms of hotspot location in open public spaces. Altogether, one hundred on-line surveys were collected.

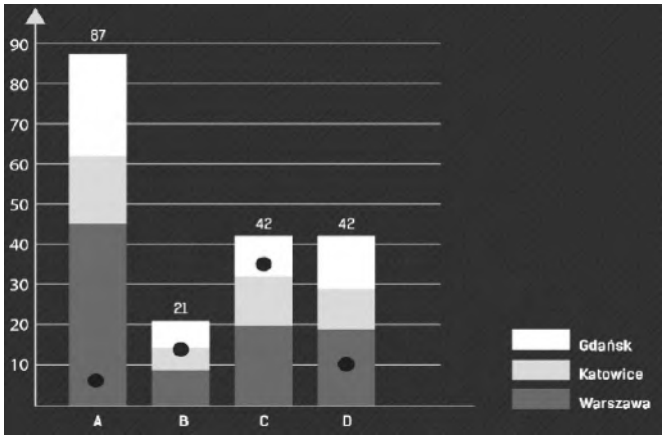
III. RESULTS

The passive observations

The passive observations were performed in four different types of hotspot settings. Figure 1 shows the number of users observed in each type of hotspot surroundings and an average length of their stay.

The outdoor hotspots located in open public spaces, without the possibility of comfortable use, have been most frequently visited by users. However, the time users spent within the hotspot area was the shortest. On average, such Wi-Fi access point were used by 15 people per hour and 80% of the Internet users were single people, using their own device quietly, without any interactions with the surroundings. The observed users spent approximately 5 to 10 minutes within the hotspot zone and they actively used their devices for 5 minutes. The great majority of users were using smartphones (94%).

The largest group observed were teenagers (42%), but also the age group of 18 - 30 years old was well represented (33%). Other observed users were older. People using the free Internet within a hotspot area for a short time usually did not care about the privacy of their screen. Approximately 80% of the users did not cover it at all, and the remaining 20% covered screens only partially. Using the Internet was usually an additional activity, mainly because people seemed to be waiting for someone or something (79%). In other cases, they stopped for a moment to rest, look around or for a quick refreshment or a snack.



● Mean length of stay within a hotspot area (in minutes)

A - outdoor hotspots located in open public spaces, without the possibility of comfortable use;
B - outdoor hotspots located in open public spaces, with the possibility of comfortable use;
C - indoor hotspots with free Wi-Fi Internet access in cafes;
D - indoor hotspots with free Wi-Fi Internet access in shopping malls.

Fig. 1. Number of users observed in each type of hotspot and the mean length of their stay.

As it concerns the outdoor hotspots located in open public spaces, but with a possibility of comfortable use, i.e. urban parks, the number of users observed there was much smaller than in hotspots without any easement. Such hotspot zones were used approximately by only 4 people per hour, however people stayed longer. On average, they actively used their mobile devices for 15 minutes, and 85% of users enjoyed smartphones. Nevertheless, it is important to point out that using a mobile device was an additional activity for the majority of users (66%). At the same time, one third of observed users didn't stop using their smartphones for the whole time spent within the observation zone. It shows how strong the need is to use mobile devices and "be-online" constantly, even while being in a park. Among all observed, single users predominated and bigger groups of 3-4 people chatting and using the Internet together were sole incidents. All observed users preferred a quiet and calm way of spending time within a hotspot zone. As it concerns the age of observed users, the most frequently represented were young people between 18 and 30

years old (52%), however teenagers were also quite popular (28% of all observed users). Users observed in the park hotspots placed more attention on privacy issues and for the majority (66%), they chose sitting places carefully enough not to show their screens. On the contrary, 14% of those observed did not care at all about privacy, and it was very easy to spot their actual activity.

Another type of hotspot are cafes with Internet access. In such places, the presence of users does not substantially depend on weather conditions. On average, in observed cafes, 7 persons per hour were using mobile devices. Among them, 47% of users were using portable computers, and moreover 90% of them were also charging the device. The smartphone users made 42% of a total number of observed people, but only 11% of them were actually charging the mobiles. The rest of the observed users enjoyed tablets without the need to recharge them. In the cafes, the length of the session was the longest in all four types of hotspot settings, and the users typically devoted more than 30 minutes to use of the Internet. In regard to the age of observed Wi-Fi users, the most frequently represented age group were young people between 18 and 30 years old (50%) and, similar to previous types of hotspots, also teenagers (40%). In cafes people more often stayed in groups of 2 - 3 people (40% of groups) or bigger than 3 people (20% of groups). As a result, a majority of observed users (60%) behaved louder as typically they combined chatting, drinking coffee or eating with checking something on a mobile phone or working together on a computer. As it concerns the privacy of screens, the users covered them partially (62%) and only a small number did not pay any attention to that (12%).

The last evaluated type of hotspot was an indoor hotspot located in a shopping mall or other service building. Hotspots in commercial buildings are a combination of external access points and cafes, as they combine characteristics of both types of hotspot. An average number of users observed within an hour is equal to the cafe hotspot (7 people per hour). The most commonly used device was a Smartphone (50%) and tablet (30%). Among all observed users, 40% of them used the possibility of charging the devices. In most cases (62%), the length of stay in the hotspot area exactly coincided with the time spent using the Internet, which was between 5-15 minutes. The additional activities, if any, were waiting for someone or something, or observation and rest (20%). As it concerns the time spent within the hotspot zone, the laptop users typically spent about 30 minutes there, and they mainly worked alone (85%) in a quiet way (90%). The rest were users in small groups of 2-3 people. The most common beneficiaries of the hotspots organised in commercial buildings were people from 18 to 30 years old (69%), and 20% were teenage users. The observed people usually partially left their screens uncovered (66%), and in case of 24% of users, one could completely check their activities, as the screens were well exhibited.

Each of the aforementioned types of hotspot allowed users to perform other needs. Therefore, users benefitted from these spaces in other ways. The collected data allowed for the initial determination of user groups, their needs and typical behaviour.

The on-line survey

The on-line survey was designed to study and explain the behaviour of users of mobile Internet, and to get to know their motivations and habits. Altogether 100 surveys were conducted, which helped to explain the previously observed phenomenon and to learn more about target groups.

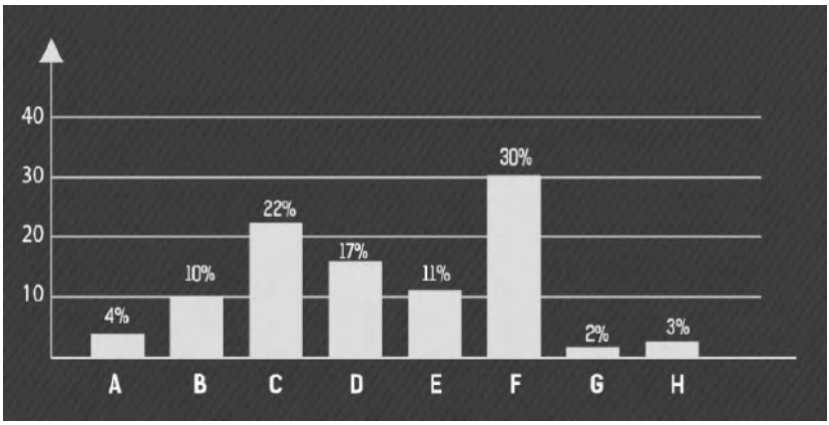
Most of the respondents are people aged between 21 to 30 years old, who regularly use the Internet, and who define their standard of living as very good or good (87%). Among all of the respondents, 65% are employed people (with a defined workplace and working hours), 15% are the freelancers, and 20% are pupils or students. The mobile Internet users in open spaces frequently use Smartphones (81%). The laptops are selected by 15% of respondents, and the tablets only by 4% of them. The motivations to use the Internet outside of the home or office are various, and for 41% of respondents it is the need to quickly check on something. One third of respondents declare that they use the Internet while waiting for someone or something to happen, or when they simply feel bored. It should be emphasised that as many as 22% of the respondents' state that they go on-line regardless of the place of their stay and their real needs. Therefore, it is true that the most frequently declared activity was to search for current information (74%), but 70% of users use mobile Internet for browsing social media and entertainment. Furthermore, only 16% of surveyed people say they use the Internet for education or work.

Currently, the most commonly stated way to connect to the Internet in public spaces is a data transfer (63% of respondents). The 23% of respondents connect via Wi-Fi, and 10% choose a source of signal depending on its quality. Noteworthy is the fact that over 43% of users connects to Wi-Fi if there is an open network, and connection quality is sufficient. It is a very common habit that users choose a free Wi-Fi connection in situations when they cannot use data transfer (e.g. while staying abroad).

The respondents were also asked about the most frequently selected location of Internet use, and 30% of respondents declare that they use the mobile Internet around the clock, regardless of time and space. In fact, they're constantly on-line (see Figure 2). The second most popular place where people use the Internet is at home (22% of respondents), and the third is public transportation (17%). Only 10% of respondents' state that they use the Internet at work.

Another issue included in the survey was a question on the most popular place to work or study, but outside the typical spaces as school, university or simply the office. Surprisingly, the most frequently declared answer to perform the above mentioned activities is on public transport (41%). The libraries, cafes and parks were declared by 18% of respondents.

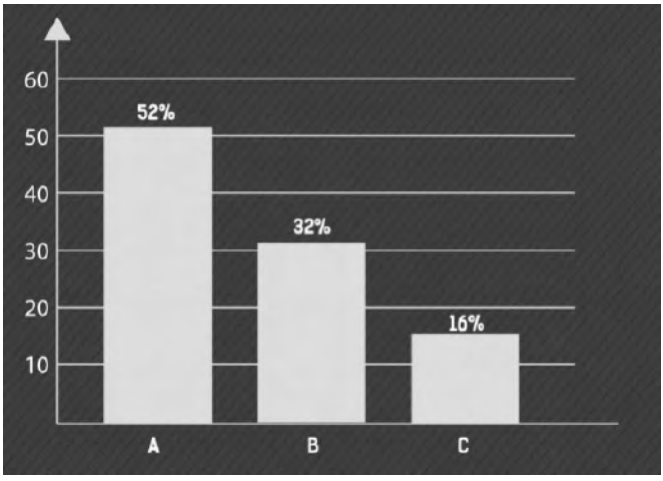
As it concerns the presence of mobile Internet, while choosing an alternative place for work or study, the majority of respondents' stated that it is desirable, but it is not the most important condition (54%). At the same time, for 19% of respondents it is the most important factor, while for 20% it is just neutral.



A - School / university; **B** - Office; **C** - Home; **D** - Public transport;
E - "I don't pay attention where and when I use Internet"; **F** - Everywhere / "I'm constantly on-line";
G - "I don't use Internet at all"; **H** - other answer.

Figure 2. The most popular places of mobile internet use.

The on-line survey questions were meant to investigate the attitude of respondents towards a specially organised hotspot. The respondents were asked if they would consider using hotspots in the future especially when located outdoors. The one-third of respondents declare a willingness to use such places and, as motivation, they mention a possibly longer time spent in the open air, a casual atmosphere of such place and an inspiring environment. Most respondents (52%) are undecided and only 16% say they are not interested at all in any type of hotspots. They explain such an attitude by stating they use the data transfer on their mobile and it is included in their overall bill for a mobile phone (see Figure 3).



A - "I don't know"; **B** - "Yes"; **C** - "No"

Figure 3. The declared willingness to use furnished hotspots in public spaces (number of users).

As it concerns the time during a day when the hotspots would be most frequently used, 30% of respondents declared the afternoon and early evening hours. More than 60% of those interviewed consider irregular usage of such hotspots. Regarding the preferred distance from home or office to the nearest hotspot, the respondents are rather open, and they do not distinguish between varying distance. A crucial fact is whether the Internet access in the hotspot is provided for free, or if the users are obliged to pay. Only 20% of respondents agree to pay extra for the Internet connection, and the most accepted maximum cost is ca. 0.5 - 1.0 EUR per hour. At the same time, 51% of users confirm that they will not use any hotspot if it requires extra costs.

The respondents were also asked about the most important features or conditions that should be fulfilled while designing a proper hotspot. Among the most essential elements or factors, the users mentioned:

- ensuring fast and stable Internet connection,
- the ability to charge a mobile device,
- a comfortable place to work,
- the security,
- the possibility of peaceful work,
- shelters for unexpected changes in weather conditions,
- aesthetic environment,
- close to restaurants and cafes.

On the other hand, among factors that are not accepted in hotspot surroundings, the respondents listed: bad weather conditions, lack of charging possibilities, lack of comfort place for work, noise, sun reflections on screens, crowded spaces, presence of insects, ugly environment and strangers who might watch them.

IV. DISCUSSION AND CONCLUSIONS

The research results presented above, supported by the literature review, let us identify 4 main groups of Wi-Fi users. Those groups are characterised by different activities performed in urban spaces. Not all users use the hotspots in the same way. Our research enabled us to observe those who are focused on work, or fixed on entertainment, the transit pedestrians, and the tourists and indigent users, for whom hotspots with free Wi-Fi access is the only way to reach a virtual world (see Figure 4).

The main characteristics of those four various user groups are presented in Table 2. Moreover, specific users' preferences and expectations in regard to hotspot design are also defined. The research results enable further elaboration of design guidelines and principles for modern outdoor ICT - friendly public space, e.g. a cyberpark.

Figure 4. Four types of mobile Internet users: focused on entertainment (top left), tourist and indigent users (top right), focused on work (bottom left), transit pedestrians (bottom right). Photo credit: N. Kołodyńska

The city is a living fabric, but in order to not only support this life, but to improve living conditions for citizens, changes are needed. Those required changes very often relate to various branches of life, and the interdisciplinary nature of urban landscapes is a key issue. Adopting the theme of the wireless Internet access points functioning in the public realm is important from the point of view of urban design and landscape architecture issues. Constantly decreasing the amount of free time spent outdoors is partly the aftermath of the lack of an alternative public space attractive for the 'digital natives' users. Thus, the research on studying the behaviour and expectations of Wi-Fi users bring new knowledge and might help to improve the design of urban public spaces.

As many opportunities as possible to stay in the open air should be encouraged by a proper urban design, so that people feel a bond with the landscape and nature. It could initiate their other "non-technical" activities. The creation of free Wi-Fi hotspots within public spaces, or in other words, cyber parks, is not a persuasion to spend even more time on-line, but it is a response to the new needs and expectations of modern citizens.

TABLE II. BEHAVIOUR OF MOBILE INTERNET USERS AND THEIR PREFERENCES AND EXPECTATIONS IN REGARD TO HOTSPOT DESIGN

USERS GROUP	USERS' BEHAVIOUR	EXPECTATION TOWARDS HOTSPOT DESIGN AND LOCATION
Focused on work	• work oriented • choose comfortable seats in peripheral location of a public space • lack of interactions with others, or if any interactions occur they are possibly subtle and non-verbal • avoid the sight of others • the mobile device is an excuse to prevent social interactions • usually come alone or in pairs • escape from the daily routine, change the pace of work and the environment • main activity: sending messages, web surfing, document preparation • the device as a tool not a gadget • the average working time is 3 hours • preferred mobile device: a laptop, tablet or a smartphone	• a reliable connection to the Internet • comfortable place for work • ensuring the long view for attractive landscape setting • a secluded site isolated from transit routes and crowded places, but enabling a feeling of co-existence in public space • the opportunity to observe the passersby • ensuring privacy of mobile device screen
Focused on entertainment	• first entertainment, then work • engaged in social interactions, often eye contact, • long stay in the same location • spending time in hotspot area as a way to meet new people • additional activities, e.g. reading of newspaper • Internet as a means for encouraging social contact • predominance of social media usage • constitute a local group, live nearby • do not pay special attention to protection of their screens • come alone, but usually meet friends in the hotspot area • engaged in environment • live or work closer, freelancers • prefer central location within a public space • average time spent 1 hour • preferred mobile device: a laptop or a smartphone	• location of hotspot in the area allowing for observations of passers-by • possibility of individual arrangement of space, e.g. mobile furniture • diversity of equipment
Transit pedestrians	• use the wireless Internet without a clear purpose, as a way for overcoming boredom e.g. while waiting for someone • sending e-mails, texting people • usually use the Internet in a standing position or in movement (walking) • short sessions (5 minutes) • the most frequently observed group in open spaces • preferred mobile device: a smartphone	• possibility of safe walking and using a mobile without any collision • iconic design, characteristic for the area • possibility of taking a short break, option for support of body
Tourists and indigent users	• they don't have free Internet access in other places • hotspot gives them a possibility to spend time in virtual world • longer sessions compared to transit pedestrians, but shorter than those focused on work or entertainment • average time in hotspot area spent is 30 minutes • preferred mobile device: a tablet or a smartphone	• location of hotspot in area well connected by public transport

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Urban development in respect to social media – The applicability of the Amsterdam city experience in other European cities

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Abstract – *Social media and digital methods provide people with mechanism that allows them to organise themselves around collective issues and to manage social and infrastructural resources in new collaborative ways. Knowledge of the best practices in the application of social media in the process of urban planning, design and social networking was gained under the Short-Term Scientific Mission (STSM) under the COST Action 1306, and these are discussed, together with a comparison of common public activities in Amsterdam and Sofia.*

It has been proven that with the possibility to support better understandings of the connection between technology, public needs and spatial development, a visual approach could bring valuable knowledge and information. In Amsterdam and in Sofia, there were similar physical activities undertaken by common people and there was not wide use of technology detected, except use of smart-phones. In Sofia, from one side there was not enough knowledge and experience in technology application for urban open space development and, on the other hand, citizens are willing to learn more about Amsterdam's good practices in urban regeneration by actively supporting social media and playful games.

The study is an attempt towards understanding the complex relationship between mobile media, citizens' experience, possible changes in their lifestyles and possible spatial development and planning.

Keywords: public use, social media, smart phone applications, public open space, playful games

I. INTRODUCTION

The city of the future will be one that grows, evolves and responds according to the needs of its inhabitants. Urban society has already entered into an era when information and communication technologies have entered into our everyday life and changed our lifestyle by making it more efficient. It is a time of rapid societal changes that requires more active involvement by citizens as amateur-experts, active participants and agents in the process of urban planning and design. The new technologies and their application enhance problem solving when there is a need for information about location, traffic routes, weather and a schedule of certain institutions and cultural events.

Social media and digital methods are the tools providing people with mechanism that allows them to organise themselves around collective issues, mobilise publics to manage social and infrastructural resources in new collaborative ways. ICTs can open new opportunities for citizens to actively shape the future of their cities by sparking new forms of civic participation, increasing social inclusion and accessibility for persons with disabilities, reducing infrastructural barriers, sharing resources, accessing relevant information and enabling a real-time dialogue in which city administrators and citizens can learn from one another. The application of ICT went even further, with the concept of "smart cities" where a central computer system could collect all necessary data for energy sources, transport, traffic, waste production and disposal and could optimise city life [1].

However, in spite of the fact that it could be a very well organized process, it is seen as too much of a top down approach where the role of the citizens is diminished to only that of a consumer. Thus, the societal transformations cannot be reduced to matters of technological possibilities and the day-to-day value of innovations is deeply embedded in the existing and newly emerging social context. It was already mentioned that cities can "*work well enough, but are open to shifts, uncertainties, and mess which are real life"* and *"should be shaped through citizens acting of their own accord and determining the rules for society together*" [1].

And because, it is known that *"we know very little about how individuals perceive the value of ICT products..."* [2], much more research about the relations between ICT, social media and people is needed.

Regarding social media, there is a different typology of Facebook, Twitter and LinkedIn users depending on their own needs motivation and level of activity. Innovative software made possible the unification of growth of processing, storage, networking and graphic platforms in one device – mobile phone - and this enabled people to stay in touch constantly. For example, in spite of the relatively slow level of economic development and social security, Bulgaria is one of the fastest growing Internet market economies in Europe with about one third of the Bulgarian population having an active Facebook profile [3].

However, our dependency on ICT and smart phones raises a number of questions that need to be answered by a wide range of professionals and policy makers, because there could be a negative impact of frequent use of smart-phones over social interactions and health. For example, specially developed mobile phone applications (app), such as "CitySense", has been used for collection of users' mobility details in order for new places to visit in urban areas to be recommended. However, by using this app the majority of individuals actually look for places visited by people of a similar age, education and taste and it led to "ghettoization" of the urban space [1].

There could be also negative changes to behaviour in terms of a decrease of safety and our everyday life. This was studied in the city of Seattle where it was discovered that *"nearly one-third of pedestrians (29.8%) were distracted by their mobile devices while crossing the street. It was found that the most absorbing distraction was listening to music*

(11.2%), followed by text messaging (7.3%), and using a handheld phone (6.2%). Compared to pedestrians who were not distracted, those who were texting took 1.87 seconds longer to cross and were four times more likely to not look where they were going, disobey traffic lights, or cross outside of the crosswalk."[4].

The role of social media, digital forms and gaming that could be the real alternative to standard formats of public involvement and public consultation in urban development had been the focus of short term scientific mission (STSM) under the COST Action TU 1306 "Fostering knowledge about the relationship between Information and Communication Technologies and Public Spaces" (CYBERPARKS)". The STSM was carried out by the author in Amsterdam in May, 2015, when the positive aspects of the use of technology and mobile phones was discovered in several cases. One example was playful activities of the group "Play & Civic Interaction Design" at the Amsterdam University of Applied Sciences, led by Prof. Dr. Ben Schouten. The mission of the group is *"...to address a changing perspective on design, one in which users is defined as social and economical factors who co-create products and services" and "With civic interaction design, we mean the design of products and services that enable citizens to improve the quality of both their individual and communal lives, and that equip them with agency to act as citizens in a media-saturated world"*. [5]

In Amsterdam there is experience in physical gaming used as a method for collaborative decision making, conflict resolution and engaging multiple stakeholders in resolving complex urban challenges, such as "Play the City" concept by Dr. Ekim Tan. This is the game designed to work with public and private clients – city authorities, consulting companies, think thanks and NGOs. It is used as a problem-solving method bringing top down decision makers together with bottom up stakeholders. [6].

"Hackable City" is a research project of University of Amsterdam (UvA), Amsterdam University of Applied Sciences (HvA), Utrecht University (UU), and The Mobile City with active collaboration with the SMEs as best practice for converting the common top down approach in urban master planning to bottom up. The project stated that: *"This is not only due to the financial crisis but also due to societal changes that involve citizens as amateur-experts, active participants and agents of change. Digital media provide people with tools to organize themselves around collective issues, mobilize publics, and manage social and infrastructural resources in collaborative ways. This do-it-yourself city making occurs in multiple domains, from energy production to the organization of healthcare, from the management of public housing to the appropriation of the urban public sphere."*[7].

Another good example of the positive impact of the participatory approach in urban regeneration is "ModelMe", a collaborative project between Burton Hamfelt Architectuur Stedebouw Prototypes and Saskia Beer from "Glamourmanifest" company. The project included innovative urban design tools and pioneering practice of door-to-door contacts and online communication with different stakeholders in the area in order for successful urban re-development of the Amstel-3 area to be achieved.

In other capital city for this study – the city of Sofia - there are a few examples of a bottom-up approach in decision-making for public open space regeneration and there is not much experience in achieving a higher standard in urban environmental quality through creating innovative urban design by using interactive media. One good example was an initiative undertaken in support of Sofia's candidacy for European capital of culture 2019 where a better cultural and artistic image of Sofia were stimulated by introducing interactive installations, engaging the citizens' attention and participation prototypes in real urban environment [8].

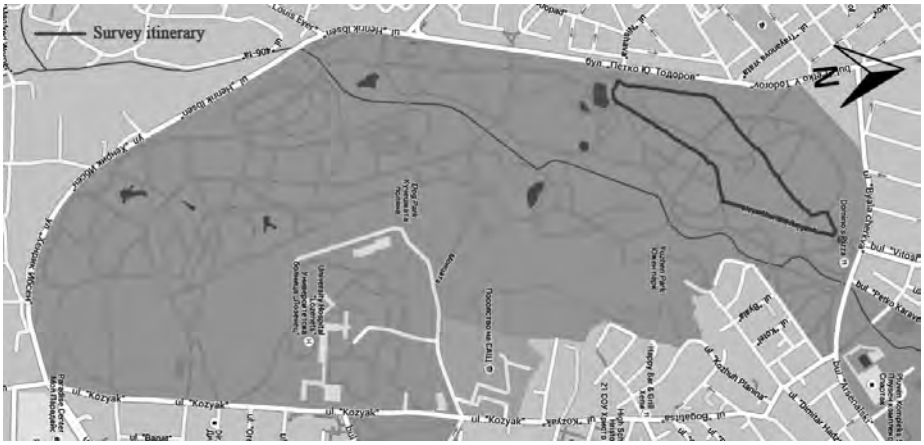

Fig. 1. Yuzhen Park in Sofia - map with survey territory marked

The main objectives of research were: 1). To disseminate Amsterdam city's experience on the relations between social media and public space; 2) To evaluate the applicability of these practices in Sofia and 3) To look at the correlation between public activities in selected parks in Amsterdam and Sofia and use of technology.

II. RESEARCH METHODS

For the purpose of the article, the knowledge and experience gained by the author during the STSM in Amsterdam has been taken as a positive starting point for the application of social media and technology in urban development. The objectives have been achieved in a three-staged methodology: 1) Introduction, discussion and evaluation of Amsterdam's good practices; 2) Visual observation and relative comparison of use of technology in selected parks in Sofia and Amsterdam and 3) A small scale ethnographic study with park visitors in Sofia.

The first stage started by introducing the selected good practices from Amsterdam ("Play the city", "Hackable Cities" and "ModelMe"), followed by a discussion about these cases with a group of 12 students from the University of Structural Engineering and Architecture in Sofia. During the discussions, participants have been asked to evaluate these practices with regard to their possibility of being applied in urban development of Sofia.

The second stage was conducted through visual observation of public activities in two public open spaces – "Vondelpark" in Amsterdam and "Yuzhen park" in Sofia. Both sites have similar characteristics – they are centrally located, multi-functional and most often visited park areas. "Vondelpark" is cited to be among the most often visited recreational places in Amsterdam [9], whereas "Yuzhen Park" is proven to be tied with most appreciated public open space in Sofia, according to previous studies of the author [10].

The third stage was implemented by a small-scale ethnographic survey and interviews with 25 park visitors of "Yuzhen Park" in Sofia. Interviews had been carried out in order to get information on social interactions and use of technology. The itinerary of the survey has been chosen in a way to cover the most visited sites of the park (Fig.1).

III. RESULTS AND ANALYSES

The information listed above about good practices in Amsterdam - "Play the city" game, "Hackable City" research project and "ModelMe" of "Glamourmanifest" initiative have been introduced to students in the field of architecture and urban planning and they have been asked to evaluate the practices presented according to their applicability in Sofia. The results are presented in Table 1.

TABLE I. EVALUATION OF BEST PRACTICES IN AMSTERDAM

QUESTION DISCUSSED	BEST PRACTICES PRESENTED AND DISCUSSED		
	Play the city	***Hackable Cities***	***"ModelMe" of Glamourmanifest***
1. Do you like the case-study? Yes/No	91% positive	83% positive´	75% positive
2. Do you think it is applicable? Yes/No	75% positive	66% positive	66% positive
3. Are you ready to use it in your practice/study? Yes/No	66% positive	41% positive	33% positive
Concluding remarks	Interesting and challenging example	In general it is applicable, but local context have be ensured	Specific knowledge, strong motivation and persistence needed
Ranking by level of applicability	1	2	3

Note: Ranking 1- the most applicable; 2- medium level of applicability; 3 – least applicable.

All three best practices have been well understood and appreciated by the group of 12 students asked. Participants stated they would like to apply such practices in their work. Concerning the possibility of being applied in Sofia, the "Play the city" concept has been evaluated as the most applicable, as this example represents a good example of simplified reality with possibly complex issues to be made accessible both to experts and non-experts.

Through this game, participants could be provoked to play a game by taking new roles and to present their views for the development of certain urban areas.

The "Hackable city" approach had been given a second place in the rankings and the reason is that it could be applied to Sofia if the local context, regulations and culture are fully considered. "ModelMe" of "Glamourmanifest" initiative had a third place in the rankings, as it was thought that it could be successful only in a case where there are persons with urban planning or architecture backgrounds, strong motivation, knowledge and persistence to be involved.

Sample photos (Photos 1-6) present comparative visual observations on public activities in the two selected public open spaces. In spite of differences in economic development and cultural industries, people have similar types of activities in "Vondelpark" in Amsterdam and "Yuzhen Park" in Sofia. The most common activities in both parks were walking, play with children, enjoying nature, exercising and resting (Photo 1-4). There were few cases when people were engaged with technology or social media, mainly using their mobile phones for talking or texting (Photos 5, 6).

TABLE II. PREFERENCES AND NEED FOR TECHNOLOGY IN VISITING THE PARK

QUESTIONS ASKED	ANSWERS IN % FROM THE TOTAL ASKED				
1. What do you do when you visit the park?	Walk 32%	Rest 16%	Sport and play 20%	Social contacts 24%	Other; no special reason 8%
2. Do you use any kind of technologies during your visit?	Smart phone 40%	Internet 16%	Games 12%	Social media 8%	Other 24%
3. Do you want to be informed about the technology regarding urban development and how?	Informational screens 28%	Smart phone apps 20%	Playful actions 8%	Social and cultural events 32%	Other; have no idea 12 %

Regarding connection between use of technology and spatial development of the park infrastructure, small-scale changes in park design have been observed. Previous study in "Yuzhen Park", conducted by the author five years ago, shows that there were certain places with free Wi-Fi access [11]. Now, with the development of mobile phone technology such places end up neglected and ill equipped (Photos 7, 8). According to participants interviewed, such places need to be regenerated and equipped with modern technology, such as informational public screens or interactive kiosks.

Photo 1. Physical exercise in "Yuzhen Park", Sofia

Photo 2. Physical exercise in "Yuzhen Park", Sofia

Under the third stage of the research, 25 regular visitors of "Yuzhen Park" were approached with the following three questions with multiple-choice answers:

1. What do you do when you visit the park? –Walk and walk the dog; Make social contacts; Relax; Sport; Play with children; Other.
2. Do you use any kind of technologies during your visit? Smart phone; Internet; Games; Social media
3. Are you interested to learn more about possibilities of technology for information and more effective participation in urban development processes? Informational screens; Smart phone apps; Social and cultural events; other.

The results presented in Table 2 show that a majority of people asked (40%) are using their smart phones, usually for talking and texting. About a third of those interviewed visited the park for walking, to walk the dogs and play with children (32%) and about a quarter (24%) used public open space for enhancing their social life. Another quarter (24%) do not use any kind of technology during their stay in the park.

In terms of the future needs of technology in the park, one third of the people interviewed (32 %) do want to be properly informed through modern technology about social and cultural events in the city. Approximately one third (28%) of those interviewed claimed that they need to have more informational public screens and kiosks. Smart phone apps are an interesting solution for about 20% of the people asked and these were predominately younger people. There were not many people (8%) interested in playful actions and about 12% - mostly older people - are not interested in the application of new technology.

Photo 3. Walking trail in “Vondelpark”, Amsterdam

Photo 4. Walking people in “Yuzhen Park”, Sofia

Photo 5. Texting in quiet, “Yuzhen Park”, Sofia

Photo 6. Playing and texting, “Yuzhen Park”, Sofia

Photo 7. Former free Wi-Fi hot-spot, “Yuzhen Park”, Sofia

Photo 8. Old fashioned playground elements near Wi-Fi hot-spot, “Yuzhen Park”, Sofia

IV. CONCLUSIONS

Professionals and experts expect that future cities will become more heterogeneous and complex. In this respect, social media and smart phone apps will enhance more active physical and social interactions and will help citizens to be more active towards accepting uncertainties of real life. Thus, with the development of technology, there is a newly emerging social context in terms of the inclusion, health care and changes in behaviour patterns that also need to be taken into account.

The study proved that a visual approach could bring valuable knowledge to meet challenges of undertaking effective bottom-up approach in urban planning process with its possibility to enhance understanding of the connection between technology, public needs and spatial development.

In the selected park areas, in Amsterdam and in Sofia, similar physical activities have been undertaken by people. There was not a wide usage of technology detected in both places, except more or less regular use of smart-phones by visitors. Visitors used their mobile phones for talking and texting and it happened at the same time as exercising activities like walking, or walking the dogs, and playing with children.

Under the case study in Sofia, it became evident that, on one hand, there was not enough knowledge and experience in the application of technology for the purposes of urban open space development. On the other hand, citizens showed a willingness to learn more about existing good practices in urban regeneration in Amsterdam that actively support social media and playful games and involvement in playful methods and social media interrelations. The students were asked if they liked the "Play the City" game and "Hackable city" concepts, because these games were seen as good examples for a participatory approach and a simplified model of a complex urban world and can create the basis for new scenarios, roles and interactions. In addition, it became clear that changes in every-day behaviour in terms of use of technology, could entail changes in the design of public open space.

The study was an attempt towards understanding how the application of social media and technology can develop collective actions around the issues of improved quality of life, environment, healthcare and education in new ways. Urban dwellers have to be able to appropriate and analyse data collected by the ICTs and smart phones in their own way. However, further research is needed for more complete recognition of the complex relationship between mobile media, citizens' experience, possible changes in their lifestyles and possible spatial development and planning.

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Greenview: The Gorilla in the Library
Smart Sensing and Behaviour Change

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Martin Rieser

Abstract – *This paper provides a description and analysis of the Greenview project, an experiment in smart sensing leading to energy consumption behaviour change in building users. Greenview was an innovative app built on the back of the successful DUALL project (funded by JISC). Where DUALL created a simple web-based information-feedback tool that could report electrical consumption in specific university buildings back to users via a simple dashboard using Yahoo widgets; Greenview refined the ICT tool further into a sophisticated smart phone application which could connect staff and students in De Montfort University (DMU) to monitor the relative energy consumptions of their buildings.*

The developed iPhone 'app' visualised comparative energy use on the DMU campus through a narrative of improving or declining habitats for endangered species, represented by animated cartoon characters living as virtual mascots in each university building. Based on the emotive nature of the 'Tamagochi' concept, the app tested an engaging way to encourage care for the environment. When consumption levels exceeded those on the same day of the previous year, the visible well being of species would change. The app also provided real-time data through meter readings provided on a half-hourly basis, allowing the inclusion of graphical data options, appealing both to emotional identification with the building mascot and to the range of preferences individuals have for viewing and interpreting data.

I. INTRODUCTION

"When citizens become involved in working out a mutually acceptable solution to a project or problem that affects their community and their personal lives, they mature into responsible democratic citizens and reaffirm democracy. One way of describing this phenomenon is to use the term social learning." [1]

The assertion by Shirky [2] is made in the context of energy, the built environment and the challenge of behaviour change. Webler *et al* [Ibid] affirm the potential that citizen engagement and participation may have on behaviour change in the form of social learning. With the introduction of the Climate Change Act in 2008 the need for action became clear. The UK was first to pass legally binding and ambitious targets for greenhouse gas emissions, specifically a reduction of at least 80% by 2050. The built environment has an important role to play if the UK is to meet this target, with almost 20% of the UK's energy consumption and CO_2 emissions arising from non-domestic buildings. Energy in buildings then is a key

strategic issue, not just for universities but for any large organisation. Both in terms of financial spend and environmental impact, buildings have a significant carbon footprint which, alongside increasing legislative drivers, creates a compelling business case to reduce energy consumption in buildings.

To date the most common way to join ICT and behaviour change has been by exploring novel ways to provide information. For example, in the field of domestic energy use, and to lesser extent the workplace, research has engaged with ways to re-connect people to energy through the use of systems that show the price, unit-cost or CO_2-cost through a live feed or half-hourly metering. Visualising energy has emerged over the last few years as a key research area for environmental scientists ([3], [4]) and has shown potential in reducing consumption by up 10-15% [5]. These interventions are based on an 'information-deficit' model – if 'they' (i.e. the users) have the right information 'they' will change behaviour. The prevailing tone of this literature and research is paternalistic, with someone-the 'expert' (or management or government), influencing other people (residents/staff/non-experts) to stop behaving one way and start behaving in another. Underpinning these approaches are often a range of environmental psychology models that attempt to unpick an individual's attitudes and behaviour in relation to energy [6]. This 'ABC' approach to behaviour change has been criticised by academics [7] who argue that behaviour is more complex and the result of deeply ingrained social infrastructures, values and institutional and organisational barriers that undermine or limit the impact an individual may have.

At the time of the project's inception, the Institute of Creative technologies (IOCT) at DMU had already developed a number of other projects, which used social media, augmented reality, GPS technology, and wiki or crowd-sourcing knowledge approaches to engage with the public in what we would term "hybrid" city environments. This ability to reach out and map layers of information onto the cityscape formed the foundation to this project. Work on iphone and Android platforms helped to add an interface combining interpretation of energy monitoring detail with immediate graphic representations. The intention was to allow micro-management of energy use, the rendering in a transparent manner of use patterns in public and corporate buildings, incorporating motivation through serious game strategies to build group and collective engagement in the problematic.

The Greenview project built on the successful DUALL project (funded by phase 1 of JISC's Greening ICT call). DUALL utilised a socio-technical solution to the design of a simple web based information-feedback tool that could report electrical consumption of ICT equipment back to users. DUALL - the 'deliberative user approach to the living lab' (DUALL) tried to recognise the complexity of user perceptions and understandings [8] the importance of combining a bottom-up and top-down approach in order to minimise mixed messages [9] and the value of public engagement ([5], [10]).

Greenview aimed to refine the ICT tool further into a more sophisticated smart phone application that would connect staff and students in De Montfort University (DMU) to the energy consumption of their buildings. We succeeded in developing an iPhone 'app' which

was launched in March 2012. The app visualised energy use in buildings on the DMU campus. It presented the buildings as living habitats for endangered species mascots, providing an engaging way to look after our environment. The app provided real-time data through meter readings provided on a half-hourly basis, and with the inclusion of graphical data options, appeals to the range of preferences individuals have for viewing and interpreting data.

Greenview utilised the expertise of two distinct but complimentary DMU research groups, namely the IESD and the Institute of Creative Technologies: the IESD was a leading research institute conducting innovative and groundbreaking research into renewable energy, sustainable development and public engagement. Current research was driven by the UK's commitments to reduce greenhouse gas emissions, increase the use of new and renewable energy technology and provide a high-quality, comfortable, safe and efficient built environment.

Whilst the DUALL project aimed to uncover whether involvement in the design of ICT-based user applications can affect behaviour change, Greenview extended the reach of DUALL and specifically aimed to transcend the traditional form of web-based representations of energy into something more dynamic and participative, which enables staff and students to not just see the energy performance of every building, but to map issues and recommendations pertaining to energy consumption onto a central website. The data was further interpreted visually onto mobile platforms, as outlined above, using visualised forms of readily digestible statistical data.

II. THE RESEARCH CHALLENGE

The specific aims and objectives were as follows, and directly related to key themes drawn from the range of research covered by the JISC Greening ICT community.

1. Creating Meaningful Data

The first challenge was to ensure the data was presented in a meaningful and accurate way. A tool was needed to provide useful and timely feedback. The key question to resolve was how to quantify the energy performance of each building and present meaningful data to the building users. All of DMU's buildings had half-hourly metering for gas, electricity and water. Data are relayed via a low-power radio network to a central receiver, and are then uploaded to a MySQL database server.

The aim was to reduce the complexity of building energy data to a simple low/neutral/high category. It had been agreed by the team to present these states in the mascot avatars as *happy, normal and sad* respectively in the final app. The approach needed to be directly calculable from 'live' energy consumption data and buildings would switch between being *happy* and *sad* over time. For this, a simple energy consumption model was developed whereby each building has its own dynamic definition of 'normal' – that is, comparing each building with its own previous consumption on the same day of the

preceding year. This had many advantages, primarily because it provided positive feedback if improvement was made and negative feedback when performance deteriorated.

Normality for each building was determined as a function of the latest 12 months of consumption. By using a rolling 12-month window, the data used to generate the 'normal' model changes over time. As new data was collected, older data was discarded and the definition of normality changed for each building. This meant that as the pattern of consumption changed the model also changed and that the baseline model was always up to date. The model itself was based on the weekly pattern because the most significant predictor of electricity consumption in the Greenview buildings was 'time of week'. The daily and weekly occupancy cycles related to building opening times and weekends determining when the building energy systems were in use. Each building had a unique signature that could be extracted and analysed.

For each of the 336 half-hourly periods in a week, an analysis of the distribution of consumption levels was used to calculate the 'normal' range of consumption values in that period using a weekly period of consumption with each week overlaid on top of each other to gain a picture of 'normal'. It became clear that the signatures for most individual weeks are similar but each week of data is unique. Also plotted in is the median (50th percentile) for each of the 336 half hourly periods.

2. Data modelling and analysis

We wanted the feedback to reduce the complexity of building energy data to a simple low/neutral/high category. It had been agreed by the team that we would present these states as happy, normal and sad respectively in the final app. The approach needed to be directly calculable from 'live' energy consumption data and buildings must switch between being happy and sad over time. For this, a simple energy consumption model was developed whereby each building has its own dynamic definition of 'normal' – we would be comparing each building with its own previous consumption. This has many advantages, primarily because it provides positive feedback if improvement is made and negative feedback when performance deteriorates.

3. Design of the App

Greenview's primary aim was to explore a funny and creative way of communicating energy efficiency that didn't just show numbers – although these were available. Our team designed bespoke animations of five DMU buildings (Fig. 1) 'Inhabited' by endangered species (Fig. 2).

For each of the five chosen buildings, a separate animation was created to illustrate the three possible states (Fig. 4) of energy consumption; 'happy' if lower than the defined 'normal' band, 'neutral' if within the normal range and 'sad' if higher than normal. The same 3 states also drive a more detailed graph, available within the app for those requiring further information. To add to the playfulness of the interface, the same three states also determined which 'top trumps' card was shown—these contained further static

information about each building, but are designed to appear more or less 'worn' according to each of the three states.

Figure 1: The five university buildings characterised as 3D models.(Design: David Everitt)

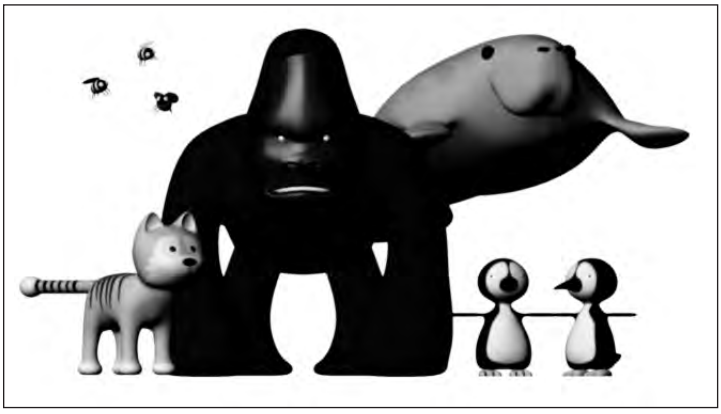

Figure 2: The five endangered species chosen to represent the buildings. (Design: David Everitt)

Before construction, a visual storyboard outline and UML-like (Fig 7) diagram was created to clarify the processes within the proposed app and—although the storyboard was changed and some diagrammed functionality was omitted—this provided the basic structure, dividing 'back-end' processes from those required in the user interface and detailing the necessary links between them. The basic structure had four distinct tiers of functionality, two of which reside on web servers, and two within the app itself:

1. The web service generating the raw data (web server 1);
2. 'Middleware' that processes the raw data for the app to use and is called by a Linux 'cron' (timed) script at regular 30-minute intervals (web server 2);

3. Javascript to read in the data and generate both detailed graphs and the three basic states—this does most of the dynamic work necessary for the app's interface to respond to each of the three states (app);
4. The presentation layer that appears to the user (app).

The app was created after some initial functional tests to rough out the basic Javascript code and check the resulting readings (http://greenview.ecoconsulting.co.uk/). Although developed primarily for Apple's iPhone and iPad (and the iOS operating system that these share), with a possible Android version in mind, it was decided that using Apple's Objective-C code would be less productive than using web technologies (HTML5, CSS3 and Javascript), so the finished app was 'wrapped' in a 'native' iOS container using PhoneGap, one of the two most popular tools for this process. The result is a native app that utilises the platform's 'web view'—an instance of the system's web browser. While slower than a native app this was not an issue as—once downloaded with all 15 videos (5 buildings x 3 states)—a simple Javascript Ajax call pulls in the latest data. A further advantage of this method is that Greenview can also be made to run in a desktop/laptop browser.

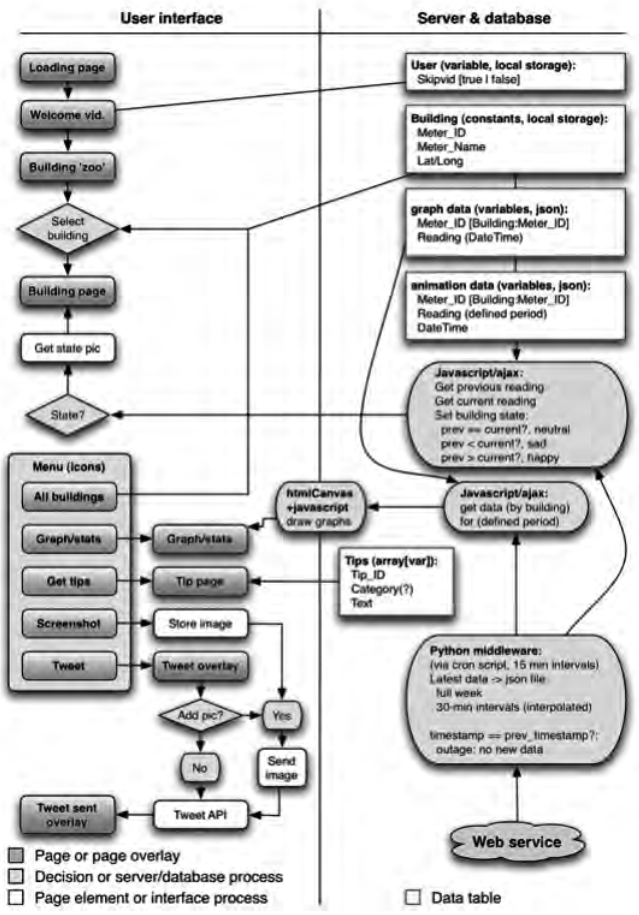

Figure 3: UML-like diagram of the proposed app.

However, it was later discovered that Android's handling of video files is inconsistent and buggy, and this—even with informal input from a specialist—made an Android version using the animation videos so difficult that the option was abandoned. The development process of the main app was captured using the version control software GIT and finally uploaded to a public repository on the GitHub social coding service, although this was not enforced throughout, and 3-4 separate 'frozen' versions of the app still exist outside version control.

The overall result enabled users to check the current state of a building at any time of day, and immediately see whether its energy use is average, below or above its usual parameters. The three states for each building pervade the entire app, and are immediately visible on the main screen. Video stills for the three states of one building are shown below (Fig 4). Much care was taken over the animations to ensure that the 'personality' of each building and associated animal had an instant visual and emotional appeal, and this has been a major factor in stimulating public engagement with the app.

Figure 4: Video stills from each of the three states for one building.

Since the launch, the processed data was continuously available to the app and, although the web service delivering the *raw data* is occasionally offline (outages are monitored using the same script that pulls in the data: the longest period was 14hrs), the code allows for the app to be used at any time with the latest available data—the middleware will pull in the latest data when it becomes available. A small code snippet using HTML5's local storage also ensures that the currently selected building is 'remembered' on the user's device until another is chosen.

III. EVALUATION

To evaluate the user-opinions on the Greenview app it was decided to organise a focus group due to both methodological choices and practical constraints. Because of time constraints

this was viewed as a better use of time than trying to organise multiple interviews and then subsequent transcription and analysis. But, methodologically, focus groups are seen by many as an extension of the interviewing process ([11], [12]), Focus Groups allow greater exploration of why people feel the way they do about a particular issue. Moreover, participants have greater control to express their viewpoint. Finally, they provide an interesting opportunity to witness how "individuals collectively make sense of a phenomenon and construct meanings around it" [11].

The Focus Group was designed and facilitated by a neutral Chartered Occupational Psychologist from Arup, with assistance from DMU. This approach would ensure a 'neutral' presence and lead, encouraging maximum engagement and output from participants, with co-facilitation by a member of the University's Institute of Energy and Sustainable Development and Principal Investigator of Greenview.

In total, 11 participants attended the session. This included seven staff and students from DMU, including environmental champions (staff from across the faculties and buildings) and a Masters student. Four members of Leicester City Council were also invited, as one of the aims of the focus group was to learn lessons from Greenview that could feed into recommendations for our participation in the SMARTSPACES project[1]. It was considered that the range of stakeholders in attendance provided a sufficiently representative sample of participants to provide a valid review of the Greenview app and input SMARTSPACES.

Following the initial welcome activities and energiser activity, participants were presented with an overview of the Greenview App, including background and context for its development, and an overview of key features. Participants were also provided with a 'walk-through' of the app using two ipads and an iphone. This enabled all participants to engage and interact with the app and ensured that all participants had a full and shared understanding of the app's features and functions. Participants were then provided with an overview of key behavioural influencing factors, gained from psychological research into the area of 'Green behaviours', to enable participants to begin to consider how the Greenview app currently might influence the behaviour of users. Various key themes for exploration, together with key 'prompt' questions, were then presented to the participants for their consideration. The key themes and prompt questions are provided below:

1. **Usability:** How easy is it to use? Is the information easy to understand? How convenient is it to use? What are the barriers to use (if any)?
2. **Design:** What design elements work well/not so well? How could the design be improved (style, layout, format)?
3. **Functionality:** Does the app provide all that it should do in terms of functions? What can or can't it do? What else should/could it do?

[1] Smartspaces is an EU CiP project (EU/297273) enabling public authorities across Europe to improve the management of energy in their buildings by exploiting ICT. DMU is responsible for the evaluation of the project alongside being a 'pilot site' with Leicester City Council. This means designing an implementing an energy visualisation tool across a range of public buildings in the local authority and the university. For further details, see: http://www.smartspaces.eu/index.php?id=629

4. **Content:** How could the content be improved? What other information should the app provide? Does the content/information help prompt you to save energy? Does it help you understand HOW to save energy? What other information/feedback should be included?
5. **Attitudes:** How do you view the app? What are your perceptions? Does the current app help you to change your views and behaviours relating to energy saving? Does it tap into your feelings and emotions? How could this be improved? Would you encourage others to use it?
6. **Other:** What else can we capture about what the app? What other positive things? What else do we need to consider in improving the app? Are people changing any aspect of their behaviour? Are people uploading information and engaging with the energy management team as a result of the tool?

In order to ensure that all participants were given the opportunity to 'voice' their ideas, they were all given post-it notes to capture personal thoughts and ideas throughout the presentation of the key themes and prompt questions, and were given a short period of time (15 minutes) to capture their individual thoughts and 'map' these onto themed flip-chart sheets provided around the room. Following a brief facilitated exploration of the ideas posted on the walls, the participants were then asked to work in three mixed stakeholder groups (two groups of four and one group of three), to further develop their ideas and to capture key ideas and develop recommendations for improvement for the app. The outputs and recommendations are provided below.

Respondents in the focus group evaluated and commented on the Greenview app from three perspectives: usability, design and content and functionality.

1. Usability

Through the discussions, the need to maximise engagement and making the app as easy as possible to use emerged as key considerations. Participants felt that in order to ensure users engage with and continue to be interested in the app and its content, the animations need a clearer explanation and to be easier to interpret. Making the app more interactive, for example through making the animals interactive, would also help maintain interest and engagement. Participants felt that the graphs ideally need to be easier to interpret, and to clearly show that the information presented is 'live'. The data needs to be intuitive and self-explanatory if such information were to be displayed on a public display screen. Several participants commented on the need for the app to be available in either a web-based or PC format, to increase the accessibility to a wider range of stakeholders. In addition, the need to consider what would prompt staff to view the information was mentioned.

Having the data available through a link on the DMU staff portal, providing prompts when starting up computers, or having the data as a screen saver/wallpaper were all seen as potential ways to make the data more easily and readily accessible to staff. Finally, participants felt that there needed to be more contextual information provided within the app (and also provided on display screens if used) to explain the possible reasons why en-

ergy usage levels are showing as high/low. This rationale would help users to understand what they could potentially do to positively influence energy usage levels, what is within and indeed outside of their control, and would also help them to gain greater understanding of the 'bigger picture' of energy use, in specific buildings and across the campus.

2. Design and Content

Providing comparative data emerged as a key recommendation. Providing energy usage data for individual departments within buildings (where possible, depending on metering capabilities), with the ability for users to select their own buildings to focus on within the app, would increase the relevance that users would feel the information had for them (since they would be able to see how their own department was performing), and would also enable users to compare their own department's or building's performance with that of others, thus creating a positive level of competition to help motivate users and promote behaviour change in relation to energy use. Comparative data would also allow monitoring of energy performance, within groups and between groups, over weeks or months as appropriate. This competition element could also possibly include 'league tables' to communicate how groups are performing, with rewards and recognition for those who are performing the best in comparison to either previous building energy levels, or compared to other groups.

Enabling the app to send 'alert' messages to users, which would prompt the user to go into the app, would increase engagement. In addition, if users were able to select which buildings they want to receive alerts about (as above), the alerts could be tailored to the specific buildings selected, and this would further increase perceived relevance to the user. Participants felt that, currently, the link between the app's content and how to save energy is not clear. Providing hints and tips to encourage users to question their behaviour (e.g. "Have you switched off your monitor?") would also equip users with the procedural information to take action to influence energy use. Furthermore, the ability to send prompts or alert messages would also be useful for security staff, to help monitor potentially 'abnormal' energy use overnight within DMU buildings.

Participants shared various views on whether the use of the endangered species was the most effective way to communicate the importance of the energy use messages to users. Participants mentioned that the animals may be perceived as too childish and would perhaps only appeal to children or younger people. The idea of using animated people, with happy, sad and neutral facial expressions, or showing them as ranging from healthy and happy to unhealthy and sad, were all ideas worth further consideration. The use of emotion and facial expression was seen as very powerful and something which should be enhanced within the app to increase the power of energy use messages.

3. Functionality

Having a 'map' of the Campus and buildings as the 'front page' display was suggested, with the emoticons (smiley faces) also featuring on this screen to give an immediate

overview of energy use levels across the campus, with this clearly labeled or shown as 'live' data. From this front page it would then be possible to select buildings to look at in more detail. In relation to the functionality of the app, clarity of information being presented again was a key recommendation. Participants commented on the need for both the graphs and the animals to be easier to understand, with the possible inclusion of tutorial or guidance information to assist users in navigating through the app effectively. The need for more animation and interactive functionality was reiterated here too; being able to interact with the data, graphs and animated features would promote engagement and understanding of the data presented. It was also felt that the graphs could benefit from showing data in smaller time increments, such that users could opt to view specific times of energy use (e.g. during a particular day), to be able to pin-point potential reasons for 'spikes' in the data.

In considering attitudes towards the app, a key question raised by the focus group participants was "Will the app engage the unengaged?" One key way of enhancing engagement was thought to be the inclusion of more, or ideally all of the main campus buildings. In addition, providing feedback (e.g. of amount of energy saved) was considered likely to be more effective if the value of the saving was communicated in units that users would be able to relate to (such as monetary value, or the number of books that could be bought for the library, for example). Providing the ability for users to be able to give feedback (e.g. using a forum, an active twitter link and feed, guidance on where to ask questions, who to phone or email), were also seen as ways of positively influencing users' attitudes towards the app, through increasing individuals' knowledge and understanding of the information presented and what they can do to respond to it.

In addition, if the app were expanded to include additional university campus buildings, it could help promote behavioural change with regard to energy use, and this was seen by participants as especially valuable for those areas or buildings where other initiatives focused on energy saving have not been successful in the past. The provision of procedural information (i.e. what individuals can do to influence energy saving) was also seen as a way to positively influence individuals' attitudes towards the app and towards energy saving, since this guidance would prompt people to act and to begin to establish new patterns and practices. Similarly, the inclusion of key messages being fed through the app from senior management (e.g. through an email link), demonstrating top level commitment to addressing energy use in the buildings would also be a welcome addition to the app for influencing how individuals view energy saving within DMU.

IV. IMPACT

The Greenview project has had a significant impact on DMU and its approach to energy management and visualisation as well as staff and student engagement. There is a general increased awareness of energy efficiency across the whole campus: the app has been downloaded by 139 staff and students across the campus and our twitter account attracted 131 followers.

A ‘go-green’ week was launched in September 2011 to encourage staff and students to reduce energy consumption by up to 25%. The Greenview team was invited to design a simple web version of the app to both monitor and communicate the savings to all staff and students. This resulted in a 13% reduction in savings based on the same week the previous year and was an excellent opportunity for the team to hone the methodological approach for measuring comparative savings.

If further funding becomes available, then we intend to address these valuable observations. Implementing these ideas into the design of the Greenview app will certainly help promote engagement with the tool and help promote behavioural change with regard to energy use across DMU. Hopefully, this over time will also lead to a gradual shift in attitudes, habits and practices, with a shift towards a more sustainable, energy saving culture in the University.

In conclusion, for the Greenview app we found that overall the participants found the tool user friendly, fun and visually attractive, however, the need for it be more intuitive and interactive, with the provision of guidance for users to help them behave differently with regard to energy use, were key recommendations.

Subject to further funding becoming available, we intend to address these valuable observations. This over time will also lead to a gradual shift in attitudes, habits and practices, with a shift towards a more sustainable, energy saving culture in the University. There is clearly a need for a web-based as well as (or instead of) smart phone accessibility and the need for two-way feedback and communications and increased links with social media. There is also a greater need to clearly communicate energy use using colour coding: red, amber and green traffic lights coding and arrows to show whether usage has moved up or down and communicating energy excesses and savings in units that are relevant and easily understandable to the user.

The research on this project will, we hope, inform and inspire other projects that harness the emotional power of empathy and identification in the development of user strategies for behavior change in environmental and other social contexts. In specific relation to the concerns of the Cyberparks network, we envisage engaging and motivating users, particularly children, in outdoor visualisations of data and information related specifically to Heritage, Nature and Sport. The clear identification with an associated *mascot's* ‘Health’ and the linking to social media via the Greenview app, provide both a conceptual model and strategy for real emotional engagement with digital data representations and the encouragement of sustained concentration on otherwise bland or un-engaging information streams.

The live updating and comparison aspects of the project add a further layer of motivation to the process and we hope the lessons learnt will be utilised in the development of apps, for example, about the trees and plants and wildlife found in open spaces and their relative growth, health, etc.; or in the comparison of relative exercise regimes within sports-related

activities in urban open spaces via similar apps. Cultural and Heritage trails in such spaces could also use animal and other avatars as guides and personalised emotional referents.

In 2012 the App won in ICT category in the EAUC Green Gown Awards out of a National Competition.

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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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People, public space, digital technology and social practice: an ethnographic approach

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Abstract – *Ethnography matters when to provide sustainable and inclusive urban spaces is an issue. Advancing knowledge on the relationship between social practices and public space is therefore crucial. This paper seeks to contribute to widening the debate about this relationship, added now by the phenomenon of penetration of ICT into public spaces. The main goal is to propose a methodological approach to guide the research in the field of urban ethnography. This approach is based, on the one hand, on long experience in ethnographic studies on public spaces, with the goal of identifying the relationship between social practices and the space in the configuration of representations and creation of socio-spatial images, particularly in urban transformation processes. On the other hand, it is based on a detailed analysis of the CyberParks Project objectives. Both allow us to better define the analysis dimensions and to identify their variables. Such framework could be used to guide future ethnographic research to be undertaken in CyberParks and beyond.*

Keywords— urban ethnography, social practice, urban public spaces, imaginary, methodological framework

I. INTRODUCTION

Technology is developing quickly and in many directions so that it becomes an inevitable part of contemporary life, stimulating the creation and diffusion of uses, but also inducing reflection and research. Locative media and the penetration of digital technology into the real urban space is increasingly calling the attention of urban designers, sociologists and experts on information and communications technologies (ICT), to better understand the opportunities created by ICT and the challenges they pose. There are already different examples of how technologies are merging into the public open spaces, e.g. digital displays in cities, wi-fi provision in parks and squares, on-the-spot tourist information, broadcasting and interactive art performances, urban games, etc. The kind of interactions is moving from those with an initial artistic, experimental or marketing orientation into a more political and academic one. Both aim to implement actions or to advance knowledge towards more sustainability and people's friendly urban development. Even if the current experiences are not goal-oriented towards urban spaces, they influence the perception and use of the real spaces, and adding to them a new dimension - the virtual, blurring the boundaries between the physical and digital. Different terms are emerging to refer to this amalgamation, as mediated [1], hybrid [2], networked spaces [3] and cyberpark [4]. These entwined spaces have now become a commonplace environment for social and public life [5]. The authors further argue that planners "must engage in the design of the parallel realities of social

and public life in these spaces" ([5]: 156). Even if ubiquitous, inter/hyperconnectivity and social network interactions as characteristics of the contemporary urban life are increasing, the links to the real world remain unchanged. People of all ages still need contact with open space, nature and with other people, in order to develop different life skills, values and attitudes [6], to be healthy, satisfied with their lives and environmentally responsible [7]. Recent research into biophilic design, restorative environments, nature deficit syndrome and technobiophilia demonstrates that a green environment is essential to well-being in both analogue and digital surroundings [8]. Therefore, regardless of unlimited possibilities ICT open, they should still be viewed as a tool, and being so they do not replace any actual open space, direct physical play and activities or the contact to nature [9]. Thus, there is a call to better understanding the relationship between people and space. In this context, the question of the role that ICT can play is increasingly pertinent.

II. THE URBAN ETHNOGRAPHIC PERSPECTIVE

In this work, ICT is considered as a potential for social innovation and motor for change, but also as a tool for social research. The consequences of the penetration of ICT into public spaces raise many questions as to what changes and challenges do ICT pose for urban spaces and therefore for human behaviour; whether ICT has potential for enhancing and building up (digital) sense of (real) place; and how to use ICT to intertwine virtual and real places and bring new/more users outdoor. At the same time, it is important to turn the viewpoint around and increase the understanding about users, people who use or do not use public open spaces, the interactions among people in these spaces, and the interaction between people and spaces. This requires an integrated approach aimed at enabling a reading of these processes towards advancing comprehensive knowledge on the appropriation of the space and social practices. Research should involve qualitative methods and ethnography, with a particular interest in methods that allow researchers to explore the connection between people, space and social practices, as well as urban design and ICT.

This paper takes up the urban ethnography perspective as essential research methodology, because it enables production of detailed information from small-scale studies. The interest lays in capturing points of view of different social actors and their cultures of use, appropriation and representation of the urban public space. This perspective draws up to deepening the knowledge of aspects related to public space users, their images, sociocultural resources applied in the appropriation of space, the temporalities involved, the relationship between these aspects and physical spaces, the typology / morphology of spaces and, finally the use of ICT and their intertwining into the physical spaces. In this context is important to observe both the everyday life, as this contributes to the identification of socio-spatial continuities and discontinuities, to situate behaviours and socio-spatial practices in terms of culture, experiences and attached meanings, as well as ephemeral experiences, those related with rituals, festivals and celebrations as well as emerging, unexpected, unconventional behaviours. Hence, the ethnographic perspective helps to gain more detailed knowledge

of behavioural scenarios ([10], [11]) and this, in turn, reveals the relationship between users, space/spatialities, time/temporalities and artefacts or objects employed (see Table I).

It should be noted that it is not necessary to tackle all the issues listed in Table I, the list is long but not exhaustive. Nevertheless, these issues usually should be considered in a socio-spatial analysis. As they are varied, it requires combining different methods and techniques for their collection and analysis. Considering just as guidance there are four main questions to be addressed [13]:

- *Who* are the users... - gender and age (in groups). Interviews enable the collection of more attributes on socio-demographic characteristics (education, marital status, occupation, place of residence and work); size users' group (if single person or group); if a group how many persons; whether it is a group of women or men; if a mixed group how many men, women, teens, adults, elderly.
- *How* they use the space ... - typology of practices – eg. walking, crossing, standing (for example, in a corner, at the entrance of a building) or sitting (for example on a bench, on the pavement, at a coffee shop).
- *What* users do ... and *what artefacts* they use ... – eg: sitting, jogging, sunbathing, talking, taking care of a child, meeting, reading a book, using ICT devices, carrying shopping bags, etc.
- *When* they use the space ... - in relationship to the time of observation, eg. hours or periods of the day – morning, noon, afternoon, evening; working days, weekend, public holidays; and frequency of use (daily, many times a week, sporadically, etc).
- *Where*, which place they use ... - regarding the typology of spaces - eg. square, street, plaza, playground, green space.

Generally, in ethnographic research the methods and procedures used are secondary data analysis, fieldwork, descriptive observations, informal and semi-structured interviews. Beyond these it could be also interesting:

- Keeping a field diary with notes about impressions, identifying the areas and/or spaces of observation; the periods of observation and users and practices observed.
- Photos and/or videos taken in different periods of observation; featuring types of users, practices and places.
- Drawings, diagrams and sketches of the local and practices observed, location of observed users; behaviour maps.

Recording the areas and time of observation should follow a systematic logic, i.e. observing areas always in the same time frame and in the same form, recording the same type of observation through the same type of resource and method.

TABLE I. SUMMARY OF THE RELATIONSHIP BETWEEN THE ELEMENTS THAT CONSTITUTE THE BEHAVIOURAL SCENARIOS [12]

ELEMENTS	CHARACTERISTICS
Users	Socio-demographic profile – eg: age, gender, place of work and home address, educational level, marital status. Relational – eg: family relationship, friendship. Socio-cultural attributes.
Times and Temporalities	Moments and periods of linear time – eg: morning, afternoon, night / weekdays, weekends. Frequencies of use and regularity of use – eg: daily, several times a week, sporadic. Sporadic use – eg: festivals and rituals, holidays, vacation. Background / life paths (person's life and spatialpractices – eg: frequency of use of public spaces, preferred places, time someone started to use a specific space). Memories and life projects (prospects of life and their relations to spaces, preferences, needs and expectations on a space). Historical time: past, present and future.
Spaces and Spatialities	Identification of the space and its main physicalarchitectural, social, urbanistic, and environmental characteristics. Forms and modes of use and appropriation – eg: behaviours and socio-spatial practices; driven sociocultural resources and the intensity of space appropriation, establishment of territories and delimitation; routes, identification, guidance. Features of the physical environment – eg: equipment, facilities, services, layout of the space, landscaping and design. Types, characteristics and composition of space – eg: shadowed and sunny places, water features. Functions - eg: areas for contemplation and for active sports, restaurants, cafés, buildings, etc. Accessibility, location within the urban fabric. Perceptions of security and safety. Perceptions of environmental hygiene - eg: noise, air quality, odours, etc.
Artefacts and objects	Identification of the artefacts and objects that are being employed. Distinguish the technological artefacts from other artefacts Identification of users and the way they employ the artefacts, considering different times and temporalities

Moreover, many of the contemporary urban public space analyses take place from a macro-analytic approach – from afar and with an outside look [14]. Such approach shows the trend towards homogenisation of public spaces in function of the economic adjustments, the strengthening of privacy and as support of ephemeral and fleeting cultures. In fact, if we want to increase the understanding of dynamics of use and appropriation of public space, it is necessary to understand the space in varied and multiple layers. These layers should pay attention to the diversity of users, practices and representations; the regularities, uses and forms of ownership; and the socio-cultural references and dimensions of public

and semi-public space ([14], [15]). In other words, it is important to understand the urban public space from the idea that social practices are a set of actions that establish the liaison between the masculine and feminine, young and old, building and street, indoor and outdoor, private and public, local and global, sacred and profane, time and space, everyday and extraordinary situations, work and leisure, real and virtual, etc. – configuring and reconfiguring the meanings of space. This justifies an ethnographic interest, that could be described as having a view from near and from inside, as it provides a useful approximation to the social actors, to their practices, and to their spatial experiences, which help to shape the social practices [14]. This ethnographic approach – from close and inside – allows recognising the space as a significant reference for individuals, with the interest to capture the micro-geographies of everyday use and appropriation of space, the behavioural scenarios, pathways, draw points, landscapes ([10], [11], [17], [18], [19]).

III. SPACE AND SOCIAL PRACTICES

Public open spaces assume a structural function in a city, defining its urban character. They influence the quality of the environment, affect the property values, promote the identity of a city or an area. Open spaces increase the aesthetic appeal, amenity and values of the urban landscape, contributing to diversify densely built up areas [20]. Covered with vegetation, they allow and maintain the presence of nature in a highly artificial urban environment. When integrated into the green infrastructure of the city, they contribute to the connectivity of habitats, enabling the propagation and protection of species and biodiversity conservation [21].

As an urban land use type and spatial resource, public open spaces are challenged through the spatial practice of its citizens in general and of the users in particular. These practices add a new dimension to the physical space - the social. Hence, the social space concerns how the physical spaces are lived and experienced by the users, generating the social practices. In light of the above considerations, a public open space embodies for the topic of this work three dimensions, the physical, the social and the virtual. The social practices are facilitated by public open spaces, as being a venue of sociability they afford the common ground for communication and information exchange. They are places for outdoor social activities, gathering places for all ages. They are places to express cultural diversity, the arena for seeing and being seen or even be anonymous in a crowd [22]. Individually the social interactions are important for contributing to our physical, cultural and spiritual well-being, for the personal development and social learning and for the development of tolerance [23]. All the above-mentioned support the change to a positive lifestyle - for all ages.

In spatial terms, public spaces are relevant for defining a sense of place that emerges through experience and knowledge of a particular area; this in turn heightens the sense of belonging to society. Thus, public spaces create the convivial, diverse and democratic urban realm, embodying the reproduction of social relations [22]. The spatial and social practices are also a result of the social structure and spatial stimulations. This means coming to terms with the fact that the design, the equipment and facilities available, and the

kind of management affect how people use the space. On the other hand, other factors as accessibility, connectivity, and especially safety, can be decisive factors for attracting, or not, users to a public open space [21].

Even when a public space is the enabler of socio-spatial interrelations, one has to consider that the urban society is highly heterogeneous with different expectations and needs. For this reason, it is necessary to demystify the relationship between public space and social interaction, a relationship often seen between the two extremes, the first with a touch of romanticism with all kinds of people gathering and sharing the same space, and the second with a pessimist perspective with social exclusion and the refusal to share the same space. This means public spaces are arenas of multiple and sometimes competing interests, occupied by people unequal in gender and social and cultural class [22]. They can be locational and situational spaces of conflict among disputing interest groups and individuals.

The modern urban environment, in its complexity, is considered one of the causes of the increasing social segregation, isolation and little involvement of people together [24]. Although as Whyte [25] pointed out, what attracts people to public spaces are other people, studies show that the majority of those who use them for leisure activities do not want to be more than mere spectators, and are not interested in establishing interactions with strangers. A study conducted in Dresden (Germany) revealed that the majority of users in urban parks, while appreciating the possibility of social contacts, have no other interests beyond a simple conversation [26]. They search for spending leisure time in a pleasant way and without interference. In a certain way, each user or group of users "privatise" their space, creating what Hampton and Gupta [27] calls a cocoon. For him the public space is not shared, but divided individually or collectively between different users or user groups. Although invisible and limited in time, these cocoons reduce the likelihood of serendipitous encounters, contradicting the common expectations for appropriation and public behaviour.

IV. THE ROLE OF ICT IN THE RELATIONSHIP BETWEEN SPACE AND SOCIAL PRACTICE

A relevant aspect of ICT is their ability to enhance communication with (potential) users and allow creative participation and community formation. ICT can be a tool to enhance the attractiveness and responsiveness of the public spaces. Through social reporting, users can share information, expose their opinions, needs and desires. GPS and other GIS supported devices can greatly inform about usage-spatial relationships. There is a wealth of evidence that the engagement of people can provoke a real change in the quality of the urban environment [21], thus improving the quality of life. The emergence and penetration of ICT has led to various forms the appropriation of the open spaces where the ICT facilities and devices play more and more a significant role. The hybrid space, along with global hyperconnectivity set urban ethnography to play a prominent role to advance knowledge on the relationship between people, social practices and places, and the resulting social and spatial interactions.

The metaphor of digitally mediated open spaces, where different access and paths are provided for things to happen, seems to be a promising line of thought. In this context, the cooperative design and decision-making processes can be enhanced with new views and approaches. More importantly, and rather than reducing people to mere users, ICT allows and demands the appropriation, change and adaptation, in an endless vicious circle. ICT and the social interactions enable therefore an evolution of a more people-centred framework not only for urban, but also for cultural, economic, and political development. In general, the provision of a framework based on cooperation can lead to an enhancement of democracy and people's empowerment, provided that the will and support to use ICT, and to develop cooperation are available. In other words, to achieve this, cities must be viewed as platforms, with citizens encouraged to utilise technology to creatively built and redefine core functionalities [28].

ICT can be therefore considered as a driving force, medium and tool, operating as a mediator between users and their virtual and real worlds. ICTs cause and enable innovative outdoor social practices, which challenge spatial and social experts to use them in policies, methodologies, design and research to produce responsive and inclusive urban places. For this work, the last topic is an important issue, as ICT opens new opportunities for socio-spatial research. Although the social practices are a well-known phenomenon, more data about users' needs and the meanings they seek in public spaces, is always welcome than these evolving in line with rapid changes in economy, society and governance.

Promising is the increasing use of hand-held GPS (global positioning system) devices. A study conducted in Lisbon [29] found that the used technology enabled an easy and simple record of data and was therefore an effective survey method that provided clear evidence of people's behaviour and movement patterns. GPS has several advantages over traditional methods for mapping spatial behaviour, as it is a cost-effective method for gathering data, and allows the precise and continuous tracking of individuals. It also provides spatially rich data, including velocity and timing information. Using GPS and geographic information system (GIS) technologies together is gaining in importance in the fields of transportation and urban planning. It also has potential as a tool used for monitoring recreational use in outdoor environments. The combination of GPS and GIS allows new types of analysis, and this can result in measures for the improvement of surveys on and planning of public spaces. Comparing the gained data with other data collection methodologies such as interviews seems to be easily achievable. There is, however, another aspect to which thought must be given. The quality of data could make such survey vulnerable, as data loss (witnessed by the study in Lisbon), or considering open and green spaces dense canopy cover can cause signal disturbance or is dependent upon weather conditions are all potential issues. Digital technology undoubtedly enhances inter/-multidisciplinary potential for research working methodologies.

V. PROPOSAL FOR AN ETHNOGRAPHIC APPROACH

A. Preliminary Considerations

One of the main objectives of the Project CyberParks (COST Action TU 1306) is to increase and advance knowledge on how to bring people to be more outdoors, enjoy public spaces and for interactive communication, recreation and learning. This makes the call for better understanding the relationship between the physical space, its features and opportunities and how people use the spaces and particularly what are people's needs on spaces ([30], [31], [32]). Within this perspective, the scientific programme of CyberParks considers three intrinsically related areas: a) public spaces along their production and design and the way people use them, b) ICT with their opportunities, novelties and potential, and c) social, behavioural and health research.

The methodological proposal is intended to be a contribution to the current discussion in the Project and draws upon the inter-disciplinary research within the Working Group on Urban Ethnography. The leading questions for this Working Group are: How do people use public spaces? What do they want from public space? Does this differ by socioeconomic status, gender, age? Moreover, linked to the use of technology and to the scientific programme of the Project CyberParks it is relevant to better understand what technological developments are most likely to change/enhance user behaviour or develop new behaviours, and what is known about the relationship between new media use and spatial practices. Answering these questions requires a careful and detailed empirical research encompassing data collection and analysis of certain socio-spatial aspects. Therefore, it is important to establish a framework to guide and define the scope of ethnographic data to be gathered and analysed. This, on the other hand, implies having to grapple with the questions posed to the Working Group, deconstructing them into single components. This means in short the need to reflect on the relationship between new media use and spatial practices in order to cover the knowledge requirements.

Considering that CyberParks' main goal is to advance scientific knowledge about the relationship between people, digital technology and urban public space, this makes the call to consider the public space both in its materiality and how people live and experience it. A framework has also to take into consideration knowledge to be gained from fields as planning and design of public spaces, including civic engagement, co-creation, and participatory processes. The final purpose is to deliver evidences and to enhance methodological and conceptual tools, both aiming at promoting innovative practices in policies and urban design that, making use of ICT, transform spaces into more inclusive and user-friendly places. The proposed approach is to be understood as a set of possibilities for thinking about and creating public spaces. Hence, for designing an ethnographic approach it is important to consider cross-disciplinarity, where the concept of social design is a key component.

B. The Framework

The envisioned approach is advanced in Table II. It is structured in two phases: (1) the interrelations between ICT and Urban Public Space (UPS), and (2) intersections between ICT, planning and citizen participation. Each phase is further broken down into dimensions, and each dimension unfolds other analytical sub-dimensions, which in turn are operationalised by variables.

These variables, as measurable representation, contribute to quantify and guide the ethnographic data to be analysed. Although these variables may possibly be better described with the use of indicators, at this stage, working on a more detailed analysis with variables and indicators is not appropriate, as defining them depends on the specific motivation and goals of each study to be undertaken. In ethnographic case studies, indicators have to be defined in accordance to study type and techniques to be implemented. Another requirement is to define scope and method to carry out the study.

Turning to the matter in hand it should be noted that Phases 1 and 2 are created solely as a matter of organisation. Although they are interrelated, they are not defined as sequential stages, but with different programmatic contents of study:

- Phase 1: Intersections between ICT and urban public space (UPS). It aims to identify the liaison between people, how they use the UPS and the role of ICT in socio-spatial interactions. This phase aims at advancing knowledge of the physical nature of a space, its functionality and people's relationships with these spaces and the meaning ascribed to them, through the analysis of the use, social appropriation, the representations, images and imaginary regarding the space, preferences, needs, and level of satisfaction with UPS.
- Phase 2: Intersections between ICT, planning and citizen participation. It aims to identify the effect of ICT on the use and intensity, number of users, citizens' participation and on the production of UPS. This through the analysis of the relationship between use of ICT, space and citizenship, of particular interest are local participatory practices, expectations on the UPS and the relationship between the logic of socio-spatial exclusion and digital divide, and results for urban planning and design of participatory methods.

The assessment of the proposed dimensions does not produce rigid results, because the framework tackles diversity of spaces and users. Each one creates systems of relations - the social practices, enriching the diversity of urban dynamics.

C. Implications of the Use of the Approach

Exemplary for some dimensions, variables are identified, as well as their analytical indicators, pointing out potential methods and technical support. This approach provides the description the specific features of the social use and appropriation of urban public space. It affords the following benefits:

- Improving the capability to respond to urban social diversity and complexity;
- Tool for mapping social practices;
- Collecting and recording data and information on space production;
- Promoting articulation between different techniques of information gathering and assessment (e.g. visual techniques of observation; interviews and surveys, etc.);
- Enhancing inter/multidisciplinary potential through the working methodologies.

The authors argue that using case studies, these five aspects can contribute to a better understanding of the use and appropriation of space by specific individuals or groups, and improve the design of socio-urban initiatives that aim to achieve social integration and participation having ICT as a mediator.

VI. DISCUSSION AND OUTLOOK

This paper reviewing literature proposes an analytical ethnographic approach that may serve as a standard for assessing and validating data on social practices, and guiding for further drawing operational methods. It also offers a perspective proposing both formative and reflective approaches that appears to reflect better the nature of the relationship between people, space and technology. The ethnographic framework discussed here refers to a close and inside view. It can also be associated with the idea of proximity and assiduousness to the contexts of study, thus making it possible to empirically detect concurring regularities and sociocultural patterns, as well as overcome the most visible expressions of the contemporary city, often associated with multiple fragmentations.

At this point, it is essential that an ethnographic study contributes towards:

- Innovative theoretical approaches on the relationship between the socio-cultural, physical and virtual dimensions, functional and environmental space, in order to promote a reflection and definition of urban design;
- Increasing the understanding of the relation between culture, society and space, the dynamics of degradation, socio-spatial exclusion and segregation;
- Going beyond a simple collection and registration of information.

TABLE II. FRAMEWORK FOR AN ETHNOGRAPHIC PERSPECTIVE FOR THE PROJECT CYBERPARKS

Phase 1| Intersections between ICT and Urban Public Space (UPS)
- The role of mediation between ICT and use of the UPS.
- The role of mediation between ICT - use of the UPS - and social interaction

DIMENSIONS OF ANALYSIS	VARIABLES OF ANALYSIS
UPS use and appropriation: • Practices and behaviours of use and appropriation of the UPS. • Relationship between ICT use and UPS use. • Relationship between ICT use, UPS use and dynamics of social interaction.	1. How people use the public space: • The relationship between the use of ICT and the socio-spatial practices. • Influence of ICT use in people's behaviour in UPS (behaviours/practices remain or are they altered?). • Frequency (hour, day, week, month) to use the UPS. 2. Social, physical and environmental characteristics and services of the UPS: • Relationship between practices and behaviours to use the UPS and the socio-demographic characteristics of the users. • Relationship between socio-demographic characteristics of users, the physical and environmental characteristics and the services offered in the UPS.
Socio-spatial representations: • Images and imaginary respect to UPS. • (Real) Needs regarding the UPS. • Requirements concerning UPS. • Satisfaction in relation to UPS.	3. How users represent the UPS: • How people interpret their relationship with the UPS, and between this relationship and ICT. • What representation do users build from other people in the relationship established between ICT, sociability and UPS use. • Identification of the most attractive elements in UPS. • Identification of the aspects less valued in the UPS. • Explanatory aspects of choice of UPS (why this and not another UPS). 4. Expectations regarding the UPS users: • Identification of needs, requirements and preferences. • Identification satisfaction level with the UPS. 5. Expectations regarding the use of ICT and increased participation in decisions concerning the production of space: • Satisfaction with the use of technological tools developed by CyberParks Project. • Identify needs, suggestions and new ideas to technological tools (secondary) support.

Phase 2| Intersections between ICT, planning and citizen participation
- The influence of ICT on the variation of intensity of use and number of users.
- The influence of ICT in citizen participation.
- The influence of ICT in the production of UPS.

DIMENSIONS OF ANALYSIS	VARIABLES OF ANALYSIS
ICT and UPS use and citizenship: • Practices of citizen participation. • Expectations of citizen participation in relation to urban space. • Logics of UPS exclusion and info-exclusion.	6. Participation and citizenship: • Mapping of participation practices. • Mapping of potential practices with digital resources (or ICT resources). 7. Using the UPS, ICT and social inclusion • Identify groups (potentially) excluded from the UPS. • Identify groups (potentially) excluded from ICT. • Identification increment aspects to promote a social inclusion through the relationship between ICT and UPS.
Planning and urban design: • Participatory methodologies.	8. Development of an interactive approach for collaborative planning and design proposals: • Design of new methods of cooperation. • Design of new policy proposals. • Definition of goals and priorities for the development of public policies.

It is important to create conditions for the analysis and construction of knowledge to enable the following:

- To put high value in the human dimensions in the analysis and characterisation in urban design;
- To take into account the users' perspective, namely in terms of symbolic dimensions, socio-spatial and cultural practices, individual satisfaction and well-being;
- To advance knowledge of the relationship between the behavioural dimensions, the sociocultural dynamics and the environment;
- To contribute to develop public spaces that, when responding to variety of social needs, set out vitality, quality and socio-urbanistic integration.

In fact, the described approach is concerned with:

- Defining and clarifying the socio-cultural aspects that synthesise practices, perceptions, interests and common social projects;
- Clarifying and emphasising the importance of socio-cultural aspects that express consistency, at the same time socio-spatial transformation;
- Identifying and highlighting the socio-cultural particularities of appropriation and organisation of public space;
- Comparing and generalising different contexts, in order to bring references and socio--cultural common practices and distinguish the most varied aspects;
- Detecting and analysing the socio-cultural aspects that, in their relationship with the space, give rise to situations of socio-spatial exclusion and segregation, as well as socio-urban vulnerability.

For both research and planning practice, it should be of interest to invest in developing an approach and analysis that consider the socio-spatial dynamics from a close and inside look and take into account the images, practices, preferences and needs of people. As Tornaghi and Knierbein [33] acknowledges the social practices change in space and through space, and these in turn change processes of space production. A comprehensive understanding of social practices enables the development of public open spaces that are designed to draw people in. The experiences show that vibrant public spaces boost the economic development, and are steps towards urban justice and sustainability.

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Cyber enhancing the Urban Soundscape

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Abstract – *Sound is one of the most direct pathways to a person's mood and emotions. Tuning the urban soundscape by enhancing the experience of existing elements or by introducing new sounds therefore allows to create more pleasant and restoring public spaces or to nudge the crowd towards a more social behaviour. For this, sounds produced by loudspeakers or mechanical systems have been used but apart from some sonic exhibitions, the installations do not allow for user interaction. This paper discusses how ICT could be introduced in soundscape design. It is based on recent findings on perception of the urban sonic environment and interpretation of the soundscape by the users of the space. Evolution in machine listening allows to adapt installations to the current state of the soundscape and open new opportunities. It is concluded that the ICT may promote urban sound planning, an often forgotten aspect of designing the urban environment.*

Keywords—urban sound planning; soundscape; mental restoration; ict; machine listening

I. INTRODUCTION

In western society, urban sound has been treated as a nuisance since several centuries. The introduction of mechanical transport, industry and amplified music in the urban sonic environment have strengthened this vision. Moreover as early scientific insight in hearing grew and analytical measurement equipment became affordable, policy has focused mainly on negative sounds and their levels. Urban sound management has been identified with urban noise control based on calculated noise maps [1] or level measurements.

However, towards the end of the 20th century, the understanding started to grow that the noise control based approach may not be well suited, in particular for urban public spaces. In this context the work of Vancouver based scientists such as Murray Schafer have often been cited [2]. With a COST project that started in 2008 the urban soundscape concept was further explored and promoted within Europe. Very useful insight in how to analyse, interpret, and design the urban soundscapes were gained [3].

In this paper the opportunities created by including cyber aspects in the design of the urban soundscape, including its perception and appraisal are discussed. In Section II this is done from the perspective of general soundscape design, in Section III from the perspective of restorative public spaces, and in Section IV from the perspective of influencing mood and social behaviour.

II. URBAN SOUNDSCAPE DESIGN

A. A classical design process

The process of designing the soundscape of an urban public space is not different from designing other aspects of such a public space (Figure 1). The designer builds a vision of the soundscape of the place taking into account the possible use of the space and the expectations of the potential users. Expectations can be quite different for different users. For example a tranquil urban space may have a different meaning for different users [4]. Some may associate urban space tranquility to social activity; others may expect nature and a small group may even be thinking mainly about silence when mentioning tranquility.

The sounds that a person identifies in a sonic environment obtain meaning in a given cultural context. These sounds-with-meaning contribute to giving identity to a place. Surprisingly, a relatively small number of sounds selected automatically based on their saliency – that is how much the sounds stand out of the urban background sound – suffice to allow people to identify their own living environment [5].

The designer's vision regarding the appropriate soundscape for an urban space can be categorised in three main classes [6]:

- Backgrounded soundscape. This vision assumes that soundscape does not contribute significantly to the experience of the space. Hence the purpose of the design is to assure that users do not notice the sounds and that they are affected in the least possible way by the sound environment. This rather unrealistic design unfortunately is a rather common vision.
- Supportive soundscape. The soundscape supports the experience of the public space but the experience is not primarily focused on sound. In other words, the soundscape has to be congruent with the vision of the space that is mainly determined by other factors.
- Focused soundscape. In this last situation, the sonic environment itself is the purpose of being in a place. Obviously, open air theatres, street performance spaces, etc. fall under this category. In this case not only the sound itself but also the acoustics of the environment become relevant. Reverberation, clarity, warmth, and signal to noise ratio have to be considered.

Based on the designer's vision a composition emerges. In this context, the word composition is used for the collection of sounds that are offered to the user and their relative strengths and noticeability.

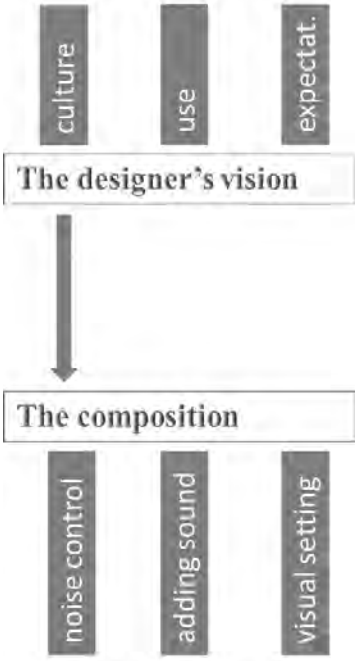

Fig. 1. The urban soundscape design process. The designer's vision inspired by knowledge on cultural aspects, the use of the space, and expectations of potential users leads to a composition. Implementing this composition requires sound control but also adding desired sounds and exploring the interaction with the visual setting.

B. Guiding attention

In composing the soundscape – particularly when its design is not in the focused category mentioned above – there is a slight difference to composing music or any other artistic expression since people visiting the acoustic space are generally not focusing on the sound environment. Thus auditory attention and noticing of sounds become important. The sonic environment experienced from within one's own dwelling is a typical example of a backgrounded soundscape and it was shown that in this situation accounting for notice-events allowed to explain some of the epidemiologic observations [7]. In the urban public space attention focusing seems equally important [8].

Thus implementing the soundscape composition should be grounded in a good understanding of what sounds users of the space are likely to notice and on the idea to guide the attention to the sounds that the designer wants them to notice. Using classical noise control, unwanted sounds can be removed from the sonic environment, and if their noticeability is high, that is indeed the only option. However, adding wanted sounds or even masking unwanted sounds by wanted ones, both energetically and perceptually/informational, is an equally appealing option ([9], [10]). As attention processes are multisensory, vision and audition will interact. Thus obscuring an unwanted sound source may in some cases result in a change in appraisal of the sonic environment.

C. The potential role of ICT in enhancing the experience

Electronic means have been used to add sounds that are usually positively appraised to a public area. This additional sound can be subtle and aim at masking or at least changing the character of unwanted sound, usually traffic sound (e.g. Mariatorget in Stockholm). It may also involve adding sound marks such as benches equipped with loudspeakers reproducing bird sound or the sound of a beach as was demonstrated in Nauener Platz in Berlin [11].

In future, ICT is likely to play a more prominent role in this process. Machine listening techniques and an internet of sound observatories [12] combined could lead to more active monitoring of the soundscape in urban public spaces. Although providing live information of soundscape quality in different public spaces in a city already has some value in itself, the real benefit occurs when a feedback mechanism influencing the sources of wanted and unwanted sounds is implemented. Such feedback could consist of playing different sounds through loudspeakers but it could also influence traffic speed, activate low emission zones, change preferred take off routes, etc.

III. RESTORATIVE SPACES

A. Classical restoration theory applied to soundscape

Classical restoration theory [13] explains the restorative potential of nature amongst others by the fact that natural environments make attention wander freely between different sensory observations. This allows the mind to relax from focused attention. The feeling of being away, fascination, peace and social cohesion increase the potential of a public space for being restorative [14].

The sonic environment can contribute considerably to all of these aspects. Sounds (natural or even human) can occasionally draw the attention of the user of the public space. Fascination or positive appraisal of unexpected yet inoffensive sounds can be created by adding sound marks or focal points to the soundscape design. These sounds can be observed as one moves around a corner into another area of the public space or they can simply emerge at a certain point in time.

Nature and by extension natural soundscapes were shown to have a strong restorative potential. Hence a possible way to understand the key features of a restorative soundscape is to analyse in detail this natural soundscape. In earlier work [15] we observed that such sonic environments behave like a complex system which leads to a 1/f spectral distribution of amplitude fluctuations (where f is the frequency of amplitude fluctuations). This spectral distribution is observed over time intervals of the order of 15 minutes. By creating artificial sounds with this temporal fluctuation one can easily observe that this condition is necessary but not sufficient.

B. The potential role of ICT in outdoor restoration

Is there an opportunity for ICT to enhance the restorative role of nature and the natural soundscape?

Non-focused attention is seldom associated with Internet, gaming or the use of computers in general. However, one could envisage an internet-based system that occasionally attracts the attention of visitors to specific parts of the public space experience. Sound is well-suited for this purpose as it is the natural way for the human perceptual system to switch to another object or another location.

Promoting classical use of wireless devices in public spaces seems contradictory to creating a feeling of being away since it would on the contrary allow people to continue their usual everyday activity. However, one could think of carefully designing internet-based services that are embedded in the public space and that enhance the feeling of being away. Connecting to the soundscape of the great outdoors, Iguassu falls, the Amazon, the Artic, the Balinese jungle from within designated areas of a public space may connect people to nature elsewhere.

Noticing different elements of the sonic environment depends on the degree of attention that the visitor pays to environmental sound but also on its degree of knowledge [16]. It has indeed been shown that knowing a sound makes noticing it more likely. Thus informing users of a park about the sounds of nature that are audible might indeed increase their fascination for those elements of wildlife and other natural elements that they would otherwise ignore.

IV. MOOD AND SOCIAL BEHAVIOUR

A. The soundscape affects behaviour

In an innovative experiment in Brighton body language was used to assess how people react to their sonic environment [15]. It was shown that appropriate sound could make people more friendly and willing to help and to reduce violence in clubbing areas. Prior literature indeed pointed at changes in social behaviour depending on noise levels in working environments and therefore these results were not completely unexpected. Yet they open a whole range of new opportunities to stimulate social cohesion, reduce violence, and increase perceived safety of public spaces in cities.

B. The cyber factor

The Brighton experiment, no matter how successful, had a couple of restrictions. Firstly the experiment in the clubbing district made the choice of mood changing sound rather trivial: music. In other areas, it might be more difficult to find appropriate sounds. Secondly, and more importantly, a well-known DJ was hired to modify the outdoor urban soundscape to influence the crowd. This involved continuous feedback. At a larger scale alternatives are needed. Internet and machine listening may help. Machine listening could grasp the

soundscape of the moment and with the aid of appropriate indicators also get an estimate on how the crowd responds. Collaborative awareness and co-creation platforms may further be used to involve the public at large in creating a soothing or exciting soundscape matching the needs of a public space at a particular time of the day or the season.

Finally local interaction with sound devices and interfaces should be envisaged, thus connecting the physical space and cyberspace more directly. Soundscapes that can be modified only by acting on the spot, leaving soundmarks only when you are there, and travelling back in time to the date of an outdoor concert, are just a few examples of possible implementations. Involving the users of the space in this way may enhance the experience of the urban soundscape in a way that we are unable to foresee today.

V. CONCLUSIONS

Several opportunities for modifying or enhancing the perception of the sonic environment and hence change the appraisal of urban soundscapes, in particular in the public space, have been discussed. Today, most applications are relatively low tech and do not make extensive use of ICT or the Internet. Yet it may be expected that an internet of sound observatories combined with different types of actuators and interfaces could either affect the elements of our sonic environment or at least change the way they are perceived by the average user of the public space. It remains a challenge for urban designers and those who teach them, to discover how to include these opportunities or to create the feeding ground for letting them emerge in a co-creative way.

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PART III
REFLECTING ON THE RELATIONSHIPS BETWEEN PEOPLE, SPACES AND TECHNOLOGY

Tweeting in Open Public Space

Case Study Belgrade

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Abstract – *Public spaces represent essential elements of vibrant, inclusive, and smart cities. Being attractive, safe, comfortable, active and sociable, open public spaces play the main role in revitalizing communities, supporting their sense of identity and culture and triggering their economic development. Considering the current trends and demands in design and use of open public spaces, the role of ICT becomes more important. This paper will present and analyze the connections which are established and intensified between users and open spaces via online social networks. The emphasis will be on Twitter which currently has around 300 million active users.*

The case study is a network of several open public spaces placed in the historical urban core of Belgrade. The analyzed network presents one of the most attractive and important urban route for pedestrians with the squares as nodes. The method that was used in analysis is the method of mapping users on the social maps (via social networks) and through the other ICT tools. It was based on a new software application – Twitter search engine – developed at the University of Nis, Faculty of Electronic engineering, during the PhD course "Advanced topics in data and knowledge engineering".

The aim was measuring the concentrations of users in open public spaces. The obtained results have enabled the determination of the image of the open public spaces perceived by the users, as well as the intensity of users and tweets through the social networks, with the aim to measure the quality of open public spaces and concentration of users. This research has indicated the potential of the analyzed area for the formation of transverse and longitudinal pedestrian flows. On the one hand they could enable active use of a selected segment of the network as one of the most important urban pedestrian route of the city, as well as to improve the image of it.

Keywords: open public spaces, Belgrade, tweets, social maps

I. INTRODUCTION

The quality of public spaces is one of the most important factors influencing the increasing intensity of its use. According to a survey of Ellaway, in neglected and devastated open public urban spaces (waste, graffiti, animal droppings) in Europe, there are three times less users than in the good designed and well maintained public spaces [1].

If we focus on attractiveness, the general definition states that it is a quality of a person or an object which causes interest of other people. By observing it in relation to a place, attractiveness quantifies how much something is able to attract the attention and influence the decisions of one or more individuals ([2], [3]) and can help to explain a variety of spatial-temporal phenomena [4]. Various methods were used to express attractiveness in a quantitative way[1], while the very phenomenon was the subject of action of various disciplines: urban design, traffic, marketing, sociology, tourism, etc.

In the domain of urban design, Jan Gehl has equated the measure of attractiveness of certain space to overall quality of a location (public open space). By establishing correlation between the quality of public open space and the number of people that spend time in them, Gehl notices that by increasing the quality of the urban environment, the level of follow-up activities increases [5]. The stated correlation is presented in a diagram where it is seen that independent from the quality of outer environment, the level of necessary activities does not change, but by increasing the quality of the environment, the level of follow-up activities increases dramatically, which causes increase in social activities. Social activities[2] are a fruit of quality and the longitude of other two types of activities, because they happen spontaneously during encounters.

Over the last ten years, digital tools, social networks and applications play the main role in our everyday lives ([6], [7], [8]). This new way of communicating has already sharpened urban life through more dynamic exchange of information ([9], [10]). Furthermore, virtual performances posted by the users of social networks such as Facebook, Instagram, Tweeter, or other open generated data, may help urban designers to collect necessary information about cognitive and perceptive impressions of the users.

During the last ten years, Twitter has grown at an exponential rate, today counting among its active users more than 4 percent of all people living on Earth [11]. On its website, Twitter calls itself "the global town square - the place where people around the globe go to find out what's happening right now". It is one of the most popular data sources for research and offers an opportunity to study human communication and social networks [12] because of its open network allowing access to information published through the platform. Furthermore, it is an important social medium that allows creative participation of users and social maps are important indicators for measuring the concentration of users and their satisfaction about the quality of open public spaces.

With the aim to research the attractiveness and quality of the open public spaces on the selected territory, we have used data provided from Twitter as a base for evaluation of the concentration of the public space users which is interpreted as a indicator of public space attractiveness.

[1] Primarily the Gravitational Attractiveness Model by Reilly and the Theory of Central Places by Christaller.

[2] They do not include children playing, greeting and conversation, mutual activities of various kinds or simply observing and listening to other people.

II. METHODOLOGY

Having in mind the general aim of the research, measuring the concentrations of users and recording the status of attractiveness of open public spaces in the city center, the focus is placed on the spatial level of the problem. The intensity and concentration of users was measured and their satisfaction about the quality of open public spaces was recorded. The research used the method of geo mapping – social maps.

Geotagging is the process of adding geographical identification metadata to various media such as a geotagged photograph or video, websites, SMS messages, QR Codes or RS feeds and is a form of geospatial metadata. This data usually consists of latitude and longitude coordinates, though they can also include altitude, bearing, distance, accuracy data, and place names. It can help users find a wide variety of location-specific information. For instance, one can find images taken near a given location by entering latitude and longitude coordinates into a suitable image search engine. Geotagging-enabled information services can also potentially be used to find location-based news, websites, or other resources. Geotagging can tell users the location of the content of a given picture or other media, or the point of view and, on some media platforms, show media relevant to a given location [13].

Geographic information systems (GIS), as the systems for storing, processing and manipulating geospatial data [14], allow the visualization and analysis to have geo-reference. Geo-information is now used on a daily basis - photos can be stored with location information, users on social networks publish their location or require the shortest path to the desired object in the city. Geographic information attached to tweets are used primarily as a mechanism for filtering [15]. Geotagging is the case when Twitter users make available their position, so others can see the exact place where the tweet was sent. Information can be analyzed based on location and profile generated by the user.

Twitter search engine is a Web application that enables the collection, storage, processing and analysis of data from the social network Twitter. It is the micro-blogging platform that provides a rich collection of real-time commentaries on almost every aspect of life. Data collection is based on the Twitter REST API [16], that allows the collection of tweets in the space defined with geo-referenced points and the given radius. This API provides a wide range of information related to their own tweets and users who post them. In addition to basic information such as text, time, number of retweets, the number of likes and information about the application from which it was posted/sent, the geographical location of where the tweet was shared presents the basis for the analysis and processing of geospatial data.

A large amount of data necessary for a successful and good analysis is the main advantage of Twitter REST API, but at the same time, availability of data only over a period of seven days from the moment of sending the request can cause major constraints and obstacles. Furthermore, this API provides the tweets that were sent in the last week within the given

radius from a predetermined location. Improvements and developments of API were necessary regarding the collection and storage of data for a longer period than seven days. In order to overcome these problems, Twitter search engine allows collection and storage of data for unlimited periods of time.

In addition to the collection and storage of data, this application offers a display, analysis and execution of complex geospatial queries of the data stored in the database. These queries are executed with the help of relational geospatial functions offered by MySQL database. These functions are correlated (i.e. there is interrelationship between the two objects determined with georeferenced points). The application also has the option of drawing a polygon on the map of Google, within which analysis has been carried out, taking into account that the site must be within the area for which information was collected.

The polygon of the research included the area of Belgrade city center and its five main open public spaces have been chosen: Kosancicev Venac, Republic Square, Sava Quay, Park near Vuk's Monument, and Slavija Square. The selected public spaces present the most recognizable nodes at the city level. Kosancicev venac is one of the oldest preserved residential areas of the city with the best position, next to the Belgrade Fortress, on the hill above right Sava's riverfornt with the one of the most attarctive vista of the city. Republic Square is the city square and the most important pedestrian and traffic node. The buildings of National theatre, National museum and lots of cafes and stores are positioned on it. Sava Quay is a recently revitalised area of old warehouses where the most interesting restaurants and clubs are located. Park near Vuk's monument is situated in the heart of the University district, next to five technical faculties and a student dormitory builidng. It is recognisable by the huge green area and underground railway station. Slavia Square is one of the most frequent traffic nodes in the city that connects the motorway with the city centre and the main train station. The considered spaces are the most frequented and the most attractive open public spaces in walking distance, within the historical urban core of Belgrade. The active use and the distances between selected open public spaces, can provide the network of transverse and longitudinal pedestrian flows which connect them and form the network [17].

The heatmap presented in Fig. 1 shows the places people like, based on the number of panoramio photos at each place in Belgrade [18]. Markers show the hottest places on the map: lighter markers are hotter. Hotness of a spot indicates the number of photos taken there. The hottest places have markers linking photos, streetview, wikipedia, wikivoyage, foursquare and google plus articles about the site. Area populations are based on the geonames database.

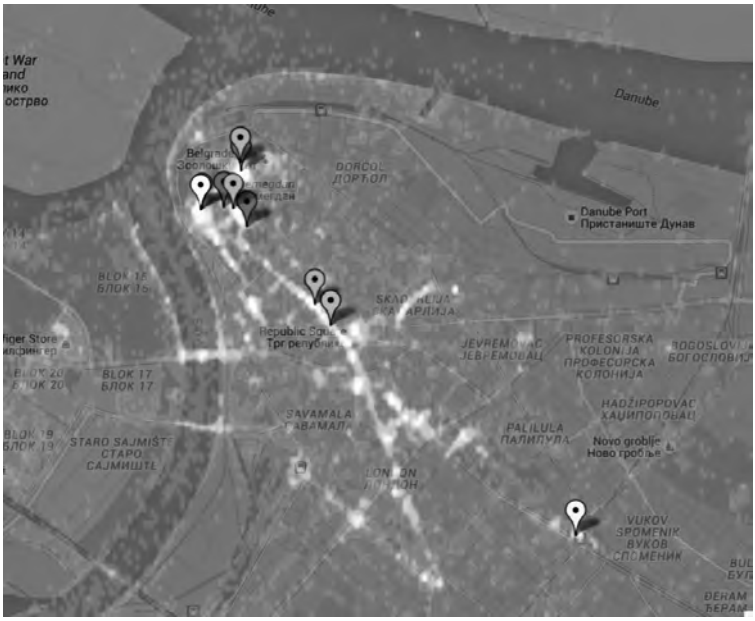

Figure 1. Hotness of a spot indicating the number of photos taken in Belgrade.

III. RESULTS

As a first step of analyses regarding geo-maping, all geocoded tweets sent between July 1st 2015 and February 29th 2016 were collected. It is important to point out that tweets were collected in predefined places of interest determined by coordinates and radius. The data illustrating attractiveness of places, based on activities of Twitter users at the Kosancicev Venac, Republic Square, Sava Quay, Park near Vuk's Monument, and Slavija Square, in the considered period, are presented in Table 1. The data about the number of geocoded tweets emanating from these locations are presented in Table 1. and Fig. 2. The most visited location was Republic Square, whilst the least visited location was Slavia Square.

A. The representation of tweets at locations of interest

In the considered period of eight months, 2,872 tweets, posted by 1,041 users were collected, which means that each user on average posted 2.759 tweets.

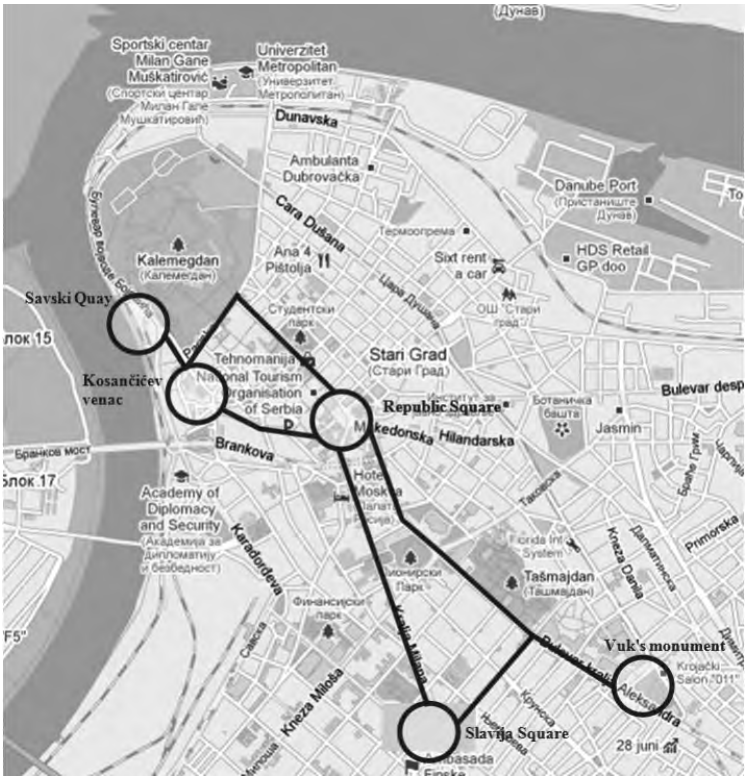

Figure 2. Spatial distribution of tweets at selected locations.

TABLE I. THE NUMBER OF TWEETS BY LOCATION

No	LOCATION	NUMBER OF TWEETS	PERCENTS
1.	Republic Square	1809	66%
2.	Kosancicev Venac	639	20%
3.	Vuk`s Monument	240	8%
4.	Sava Quay	155	5%
5.	Slavija Square	29	1%

The activity of users on a monthly basis is shown in Table 2. and Fig. 3. On average, 359 tweets per month were collected. The users were most active during September, with 440 tweets, and the least active during January with 233 tweets. According to the collected data, it can be concluded that largest number of tweets has been posted in Republic Square during September (314) and the second largest were posted in the same location during July (263). During August there were no posted tweets on Slavija Square which is, at the same time, the location with the least number of posted tweets during each month. Significant difference in the number of tweets by months is noticed at the location of

Vuk`s Monument. This fact can be connected with the classes during winter semester and presence of the students, because the recorded number of tweets is two to five times higher during the semester.

TABLE II. THE NUMBER OF TWEETS BY LOCATION AND BY MONTH

No	LOCATION	NUMBER OF TWEETS BY MONTH							
		JULY 2015	AUG. 2015	SEP. 2015	OCT. 2015	NOV. 2015	DEC. 2015	JAN. 2016	FEB. 2016
1.	Republic Square	263	237	314	206	217	213	147	212
2.	Kosancicev Venac	66	80	69	85	98	73	66	102
3.	Vuk`s Monument	26	16	27	49	48	48	8	18
4.	Sava Quay	12	13	26	30	16	27	10	21
5.	Slavija Square	3	0	4	11	2	4	2	3
	Total	**370**	**346**	**440**	**381**	**381**	**365**	**233**	**356**

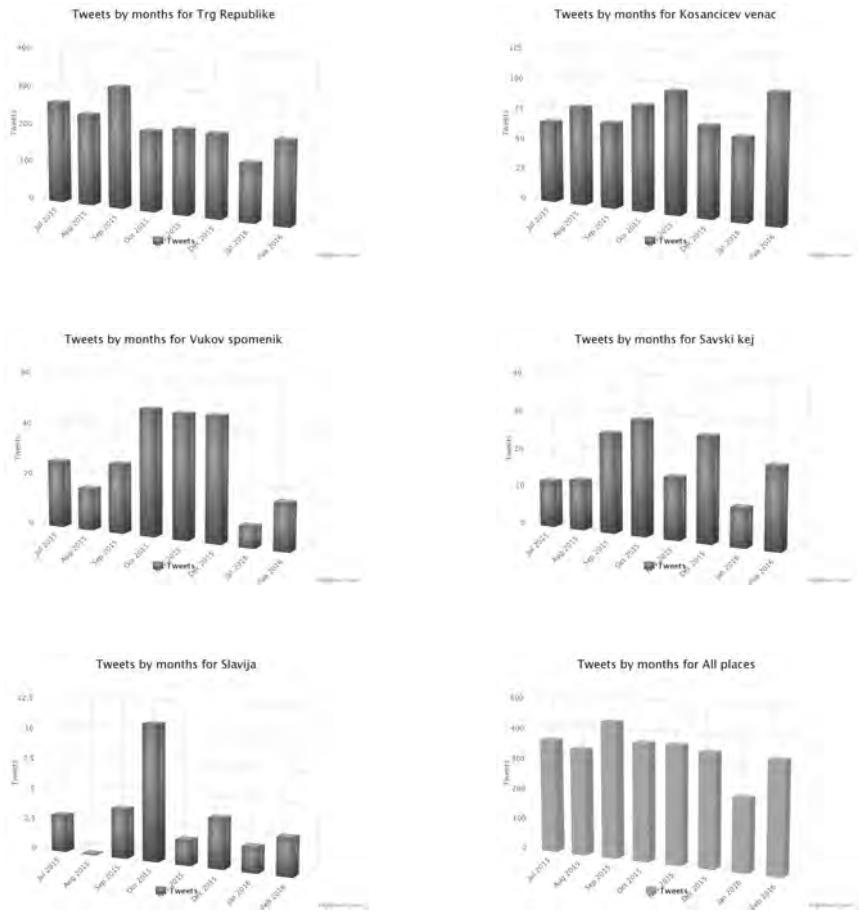

Figure 3. Number of Tweets on a monthly basis per location and for all locations.

B. Applications used for post and content of tweets

The users posted 2,872 tweets at selected locations by 15 different applications. Distribution of tweets by applications that are used for their sharing is not equal. The most popular social network is Instagram with 1,325 tweets (46.1%), following Foursquare with 1,215 (42.3%), while other applications are represented with 332 tweets (8,9%). The popularity of applications for sending tweets varies according to the location from which the tweets were posted. Regarding the application from which the tweet was posted, it is possible to conclude about the content of the tweet. Three categories of the content of tweets are presented in Fig. 4. and 5. Foursquare is a location-based social networking website for mobile devices, such as smart phones. Users "check in" at venues using a mobile website, text messaging or a device-specific application by selecting from a list of venues the application locates nearby.

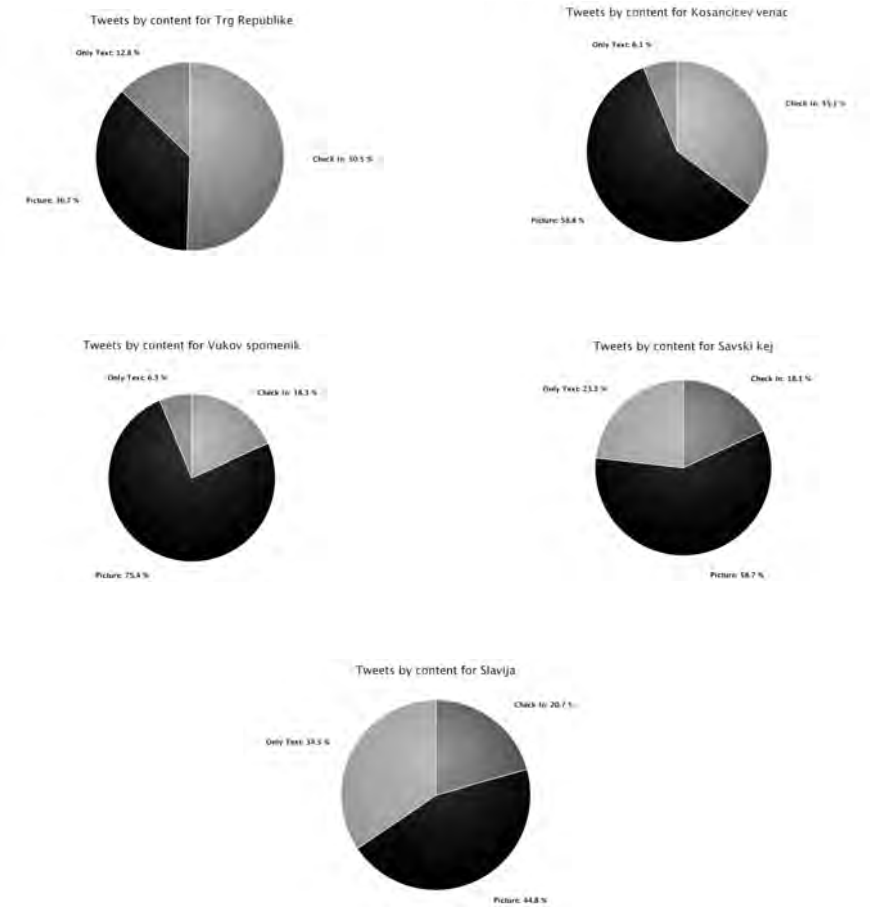

Figure 4. Distribution of tweets according to the content at selected locations.

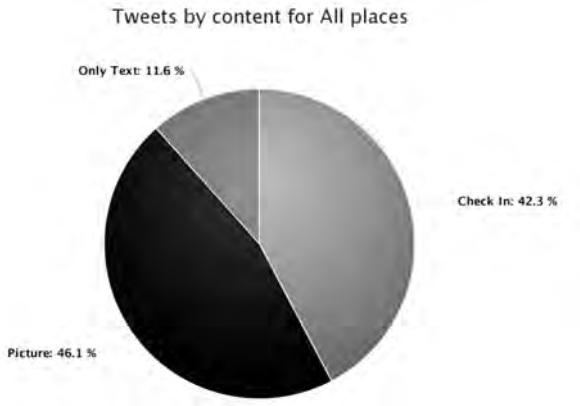

Figure 5. Distribution of tweets according to the content for all locations.

Instagram is an online photo-sharing, video-sharing and social networking service that enables its users to share their photos and videos, apply digital filters to them and share them on a variety of social networking services, such as Facebook, Twitter, Tumblr and Flickr. The social network Instagram allows users to add different types of filters, a specific figure on which we can make conclusions about the content. Users most commonly take photographs at the locations of Kosancicev venac, Vuk`s Monument and Sava Quay, while the Republic Square is the most popular location for CheckIn. Slavia Square is the location where the most tweets (34,5%) are recorded in relation to other types of social network content.

C. Popularity of tweets

A large number of factors influence the popularity of the tweets, but the two mos important ones are the number of followers of a user and information about user activity that is, how often the user post the new tweets. Accordingly, popularity of tweets can be divided into two categories: the popularity based on the number of shares (retweets) and the popularity based on the number of "likes".

The most popular tweets based on the number of shares, or retweets, are presented in the Fig. 6. As can be noticed, even 9 of the 10 most popular tweets are posted on the Republic Square. Furthermore, only 3 tweets are posted by foreigners, while the other users are citizens of Serbia. The most popular tweets regarding the number of "likes" are presented in Fig. 7. Popularity based on support (Like) is most evident in the locations of Republic Square and Kosancicev Venac. All the tweets are posted by the citizens of the Republic of Serbia.

Finally, as an illustration, the most popular tweet in both cases during the period of eight months is the one that describes the changing identity of the most important open public space within the historical city core. It consists of six words "Once bookstore "Yugoslavian books" today MaxMara" (Fig. 8).

#	Ime	Text	Mesto	Broj deljenja
1	Kompjuter biblioteka	U 6 reči : Nekada knjižara Jugoslovenske knjige, danas MaxMara. http://t.co/OOjckdacpo	Trg Republike	15
2	Jovana Gligorijević	Medija centar, sad. KZN povodom zabrane #sedamhiljada #SrebrenicaGenocide20Years http://t.co/FwOZfowtRz	Trg Republike	6
3	André Fran	Na Sérvia, em um centro de distribuição de mantimentos para refugiados, um menino sírio desenhou a... https://t.co/RCQPAwZmfh	Trg Republike	5
4	Sergey Ponomarev	#refugees travel by train as go to #belgrade. #migrants #refugees #nytassignment #onassignment... https://t.co/Xw1Yr3qDT0	Trg Republike	4
5	Jovana Štetin	Nedeljni ručak kod tašte :) @ Beograd na vodi https://t.co/epv18byXnC	Savski kej	4
6	Milos Djajic 6962	#zonabezmrznje (@ Trg Republike in Beograd) https://t.co/rugcibwift http://t.co/ExM4vjEQz2	Trg Republike	3
7	Tanya L. Domi	Beograd Pride! @ Beograd https://t.co/tOc6ElQF5d	Trg Republike	3
8	Gr. opština Vračar	U @SkolaRibnikar čestitali smo prvacima/kinjama proces godine, poklonili im knjigu i deo pribora :) Srećno! http://t.co/TRIETljk9M	Trg Republike	3
9	Milena Rasic	💣	Trg Republike	3
10	Milos Djajic 6962	Medjunarodni dan demokratije i KZN (at @Medijacentar in Belgrade) https://t.co/JVBgsCDp9v http://t.co/DwWYrRdCly	Trg Republike	2

Showing 1 to 10 of 10 records

Figure 6. The most popular tweets based on the number of retweets.

#	Ime	Text	Mesto	Broj deljenja
1	Kompjuter biblioteka	U 6 reči : Nekada knjižara Jugoslovenske knjige, danas MaxMara. http://t.co/OOjckdacpo	Trg Republike	49
2	N E N A	Panic Ljiljana Marija 25.07.1936 -14.07. 2015. Moj drug, moja sreca, podrska. Moja draga majka.	Trg Republike	44
3	SEDMA SILA	"Beograd na vodi" Da li dobro vidim da se ne dešava ništa na lokaciji? Faza 0 A	Kosancicev venac	34
4	Zoran Čičak	Malo istorije... Branislav Nusic (u sredini) sa prijateljima, pocetak 1930-tih. Moj deda Milorad, stoji treci s desna http://t.co/YEwEuV9BTk	Kosancicev venac	29
5	Natalija Jeličić	@Blondie_Yeah and me❤ http://t.co/t1z1rIRZOX	Trg Republike	26
6	Jovana Gligorijević	Svaki put kad premijer podigne naočare, jednoj pandi umre mama.	Trg Republike	26
7	SEDMA SILA	Koliko je sve u ovoj zemlji otišlo u PM ako uzmemo u obzir koliko ljudi ima, a medju njima i poznatih ličnosti, koji nemaju struju.	Kosancicev venac	24
8	LUTKA IZ IZLOGA	Dobro jutrooooo ❤ (@ Knez Mihailova in Beograd, Central Serbia) https://t.co/pCSeibCvb9 https://t.co/IRA6q739OT	Trg Republike	21
9	kamila na kisi	Nesvakidasnja ljubav usla je tiho, na prstima u moj mali svet..	Trg Republike	21
10	kamila na kisi	http://t.co/3AVui5wRHq	Trg Republike	18

Figure 7. The most popular tweets based on the number of "Likes".

IV. DISCUSSION AND CONCLUSION

The results of the analysis in this paper represent only part of the possibilities of Twitter search engine application. In general, the social network Twitter is convinient for this type of research, since the platform (REST API) provides support for data analysis, primarily based on a large amount of public information that is crucial to any successful analysis.

According to the analysis of data collected during the period of 8 months (July 2015 – February 2016) in five of the most important open public spaces within the historical core of Belgrade: Republic Square, Kosancicev Venac, Vuk's Monument, Sava Quay and Slavija, it can be concluded that each user has sent 2.8 tweets on average and that the users were the most active during September. The users posted tweets via different applications, mostly through Instagram (46.1% of all tweets), and Foursquare (42.3%). Accordingly, 46.1% tweets contained pictures, 42,3% of the tweets were used only for CheckIn, while only 11.6% of all tweets contained text-only. According to the data provided by the research, the number of open public space users are not equally distributed on selected open public spaces. Republic Square is the open public space with the largest number of tweets, with 66% of all collected tweets. Republic Square is next to the main street Knez Mihajlova and within walking distance of the Kalemegdan fortress and park. Furthermore, other points of interests for public space users such as facilities, parks, cafes, restaurants and shops are in large numbers near by. It is obvious that the concentration of activities provides the concentration of users and pedestrians. On the other hand, Slavija Square is the location with the smallest number of Twitter users. It is an attractive public space but mostly dedicated to traffic with less concentrated activities than in Republic square or Vuk's Monument. There are large groups of pedestrians who are just walking through the locations and usually do not stay more than is necessary for passing through it.

The fact that the most popular tweet from the location is the one dedicated to the image of the place, collective identity is also very important for our survey. It can be concluded that the constant changing of the image of the most important public spaces within the historical city centre, even if it is only changing the activities and functions, is one of the main concerns of the Twitter users. Globalization and insisting of unifications of all main streets and squares regarding the types of activities and brands in shops, could provide less interesting places without identity. Futhermore, so called "no-places'' can contribute to users feeling like they are at home in every town or city worldwide. In general, data from Twitter represents an excellent basis for different types of analysis. All analysis that can be performed in the context of this application can greatly help in designing urban plans for the city. They can also be used to test the attractiveness of certain locations, and public open spaces in the city, as well as their mutual correlations.

Figure 8. The most popular tweet for the period of 4 months in selected locations – "Once the bookstore "Yugoslavian book", today MaxMara".

In this regard, the possible directions for future research are related to the semantic analysis of content, such as classification of positive and negative impressions based on tweets, as well as the creation of the happy user traces.

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The Principle of Geotagging
Cross-linking archival sources with people and the city through digital urban places

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Abstract – *This article discusses technical solutions for representing archival sources in urban areas. We strive to realise the interconnectedness of sources, its beholders and the concerning entity through the location where the information was recorded the first time. This will be exemplified by a recent project at the University of Graz. Thereto, we need to identify problems in the analogue world mainly dealing with the classification of archiving, semiotic systems, descriptions and assignments. We use existing mobile technologies and software applications from different application fields and test their suitability for our concern. Comparing and transferring analogue methods to the digital world is a real challenge we like to accept when it comes to solving identified problems that arise in the context of modes of practice in archives and web representations.*

Keywords - geotagging; augmented reality; Graz; Heinrich von Geymueller; reference; semantic web; metadata; digital semantic web; digital archive; architecture-related archive.

I. INTRODUCTION

We developed an awareness of the problem addressed in this paper during our work on a recent research project that started in December 2014. The project especially refers to the handling of architecture-related archival sources [1]. It intends to digitalise the scientific legacy of the Swiss historian of architecture *Heinrich von Geymueller* (1839–1909). This legacy has been situated at the Institute of Art History at the University of Graz since 1927. At the beginning, our work concentrated on the preparation of a suitable web representation. Purposes of digitalisation of more than 71,500 single objects eventually encouraged ideas focussing on the optimisation of message qualities of archival sources.

Traditional and analogous work in archives has been experiencing innovations for years, in terms of the digitalisation of archival materials. Renovation, retention, and order have substantially changed through the inclusion of information technologies. The data recorded and systematised in the archive will be transferred, stored and thereby provided to users in the World Wide Web, autonomous from time and space. Digitalisation can imply the occurrence of mistakes. The use of different browsers or software preferences often gives rise to deviations. The majority of archives work with searchable metadata. The latter are

easy to incorporate and flexibly applicable. But, incorporating metadata often leads to inconsistencies. Such data are indeed necessary for administrating archival materials, but it is of limited interest to the World Wide Web, because essential information, like being in conjunction with contents, is completely left out or is not possible at all. The following sections discuss several problem positions concerning the handling of different archive sources by using digital methods. Results are presented directly afterwards. The case study will give an overview of concrete implementation possibilities.

The preparation of web representation approaches was preceded by investigations and observations. These investigations dealt with recent projects of digitalisation and established web representation practices. Our investigation exhibited that the transfer of architecture-related source materials in web applications needs special treatment due to different semantics (see II. A.). This insight led to a further discourse about the message quality of archival sources both inside and outside the archive. This discourse also comprised the question to what extent the message quality could be increased through localisation in the urban area (see III. C.). It has to be noted that a qualitatively good research result in a web application mostly requires expertise in dealing with sources.

II. FIRST ANALYSIS: PROBLEMS IN DEALING WITH DIFFERENT SEMENTICS

II. A. Different mediality of architecture-related archival sources

Architecture-related archives normally show a broad spectrum of sources, that is richer than average. This became clear in a comparison of recent projects of digitalisation discussing various topical contents [2]. Historical legacies of the architects *Herbert Eichholzer* (Archive, Graz University of Technology), *Heinrich von Geymüller* (Archive of the Institute of Art History, University of Graz) and *Clemens Holzmeister* (Archive of Architecture, University of Innsbruck) make it exemplarily evident that particularly the categorical order of image and plan source requires a specific treatment. Initially, we generally differentiated between image and text sources:

Image sources are among others photos, graphics, prints, sketches, plan drawings or design drawings, etc. In general, they have to be described differently because of their imaging, rendering or instructing function. Plan and design materials can both be rendering and instructing and are either assigned to realised or not realised projects. In the case of *Geymueller's* legacy it made matters worse that such image contents are also a question of notional depiction and / or reconstruction projects. Among a wide range of different image sources, as it is the case with *Holzmeister's* legacy, which encompasses 239 plan and design drawings, as well as more than 9,000 original photos, the three archives mentioned above additionally contain different genres of text sources.

Text sources are mainly represented by sketchbooks, notes and contemporary newspaper clips. The *Geymueller* case features a wealth of transcripts, excerpts, manuscripts, proofs, invoices, delivery notes, tables, and documents of correspondence like letters and postcards.

This wealth is to be credited to the distinct research and publication activities *Geymueller* had undertaken. The notepads had to be differentiated in terms of published and unpublished contents. Handwritten notepads and sketches cover an enormous amount of the overall text sources, accounting for more than 71,500 objects of *Geymueller's* legacy. Some of them are significant because they include unpublished information. These notepads and sketches are, together with many plan drawings, an exception, because they comprise both figurative and textual semantics.

Hybrid sources are denoted as such only if they contain both figurative depictions and textual parts, and thus can be analysed in terms of both image and linguistics. The hybrid sources in the three archives considered in our research primarily mattered in the form of sketches and sketchbooks, sometimes also in the form of plan materials and all types of design materials. In some exceptional cases, there were inscribed photographs and labeled letters, which did not allow a clear assignment to the classic image or text sources.

Audio and video sources are not available in our research project, but should be mentioned for the sake of completeness.

II. B. Full-text image search

Digitalising analogous data and processing into digital representations always involves a loss of meaning in favour of precision of the message [3]. The notion '*semantic web*' signifies to integrate relations between digital data, such as image sources and text sources. In databases this is currently achieved by standardising metadata (Dublin Core [4], metadata encoding transmission standards (METS) [5], etc.) and by deploying methods of the text encoding initiative (TEI) [6] or the resource description framework (RDF) [7]. Since 2000 there has been a standard, the General International Standard Archival Description (ISAD-G), which unifies the presentation data of the world and inserts data into databases, recorded in a standardised manner [8].

The following problem for the web application results from this: Through the digitalisation and digital gathering of text, image, and / or hybrid sources, only a full-text search can be conducted on the basis of conventional methods so far. This current standard of searching cannot satisfy the central aspect of an archive presenting the entire stock as a collection of diverse relationships.

Results – The handling of different semantics and full-text image search was accomplished through a new data model. It is based on a reference-plane system that does not make any distinction between image and text-based data, but includes hybrid sources. The data model is presented in more detail in the case study (IV.). This reference-plane system focuses not only on the metadata but also on the performances of the content.

III. SECOND ANALYSIS: MISSING REFERENTIAL MESSAGE QUALITIES OF ARCHIVAL SOURCES IN ARCHIVES AND WEB APPLICATIONS

The following observations and considerations were guided by theory-driven analyses and arose empirically while working on the *Geymueller* archive legacy. Thereby, we realised semantic communications problems, which concern the work with sources in archives (analogue location) as well as with representations in web applications (digital location). Recognised deficits resulting from that finally led to the consideration and review of opportunities to semantically reference archival sources to the location where the original uptake stems from.

III. A. The sum and performance of an archival source's features

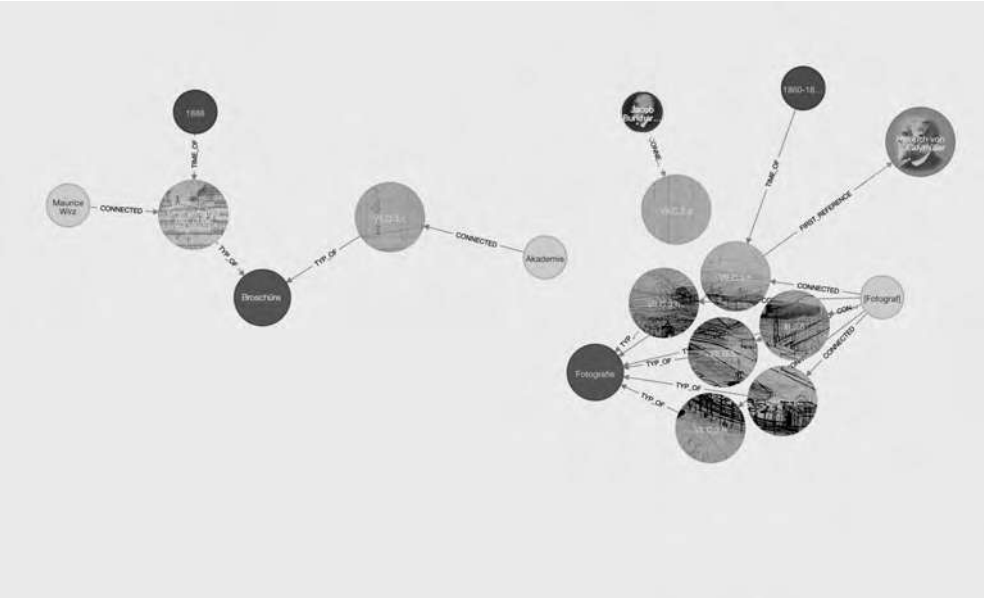

Fig. 1. Relation structure referring to Brunswick's model:
The sum and performance of an archival source's features *(Author).*

An archival source's quality is viewed as subject to the sum of all features assigned to it (message) [9] and the features' performances among each other (see II. A.). Furthermore, references to one or several tangible or intangible objects (entities) [10] outside of the archive (see II.C.). The first two "message values" - sum and performance - basically trace back to the model of the gestalt psychologist *Christian von Ehrenfels* as well as to observations of *Egon Brunswik* [11].

Ehrenfels realised that the result is not only the sum of parts in a whole, but also the perception and cognition of the whole conditioned by its parts, thus the whole is more than the sum of its parts [12]. Transferring this insight to an archival source, this means that an entire message about it can only be made, in an analogue sense, on the basis of

the sum of all its parts' features (material, formal, and content-related) in consideration of their relations to each other. Examples for individual features are texture, origin, depicted content etc. Every individual message can only be interpreted properly by taking account of the source's entire message. Altogether the messages eventually yield the first "message value", which we term 'the sum'. In the digital data processing, this value can be produced through appropriate visualisation methods and automatised information gathering, too [13].

The second "message value" is `the performance´ (*see fig. 1*), which is achieved through the consideration of relationships between individual messages. The coherence of parts observed by *Brunswik* [14] corresponds to the work in an archive insofar as the relationship between the message about the origin and the content are mutually dependent, for example, because a geographic indication related to an archival source can be a pointer to the content and, conversely, provided that the relation to one or several other indications (see III. B.) or objects outside of the archive (see III. C.) can be confirmed [15].

What we were trying to reproduce by means of these two models firstly was for the first two values of the message quality, which applies through the summation of all individual messages and the consideration of its relationships to each other (see II. A.). It took many years after the models´ foundation until the digital image is today regarded as its best representative: Many different chromatophores (pixels), considered separately, result in an entire image. The respective proportion of them only arises through the image itself (*see fig. 2*).

Fig. 2. Well-ordered pixel content of an envelope. *(Author)*

Always regarding the quality of sources in the context of other sources as well as in the overall context is the essential insight. When the sum is reduced, the cognitive quality of individual archival sources decreases, too. Sighting the entire archive legacy of *Geymuller* finally confirmed the proposition previously stated. Neither the representation of individually selected archival sources would make sense, nor the digitalisation of the entire stock of more than 71,500 objects would be possible. That is why the stock is differentiated

topically. This resulted in a prioritising classification and a selection of about 18,000 archival sources that have to be digitalised. The challenge associated with this reduction consisted in compensating the summary reduction by appreciating the conjunction/performance of archival sources in order to fairly maintain the quality of the message.

III. B. The performance of archival sources within an archive or a web application

The work within an archive is shaped by a concatenation of individual insights, which in total joins an entire insight. We tried to construe the two epistemological models of *Ehrenfels* and *Brunswik* as connections between the archival source and the archive or the web application.

Example *– As we observed the processing of a single sketch of Geymueller's archive legacy it became visible that we only could convey a single message about the sketch's semantic features (quickly sketched architectural details) by joining and linking tangible and formal features (texture of paper, curvature of its corners and traces of tearing at the sketch's long side). It was the comparison to two other archival sources (sketchbook and list)* [16] *that enabled us to make a clear classification and assignment of the content. The latter could finally be assigned to a specific building that Geymueller had visited and sketched on one of his journeys through Tuscany (see III. C.). Moreover, it could be reconstructed that Geymueller later extracted the sketch from his travel sketchbook in order to file it away with other non-geographic and non-chronological, but topically similar sketches, probably for his work on a publication.*

With regard to the relationship between the archival source and the analogous archive it was particularly the unfavourable classification system that was apparent. Contextual search capabilities are barely possible without having more exact knowledge about the entire stock and, for this reason, also without having an expert on board. The digital opening of the archival legacy entails new user profiles and, thus, requires new search capabilities and by association other comprehension criteria. These should partly replace the cognitive processes from the analogous archive and, moreover, also compensate the knowledge about the entire archival stock.

This should succeed if performances between individual messages are considered. In order to attain a qualitative message, it is not only necessary to make the sum of individual messages and its performances accessible (see III. A.), but also to crosslink them to individual messages of other archival sources that are topically, chronologically or geographically affiliated (see III. B.). In addition to it, it is necessary to make external objects accessible, i.e. objects that are located outside of the archive (see III. C.).

III. C. The missing semantic referencing with tangible and intangible entities outside of archives

It is necessary to establish conformity between source and object whose ontological prerequisites are largely different, so that their performativity declines. And, due to translation difficulties, breaks and differences are possible. External objects *Geymueller* referred to in

his sources, and whose ontological domain is also verbal and thus ontologically similar, are mainly sources from other collections or archives as well as from publications. Ontologically different objects are mostly tangible entities like artifacts, persons, spaces or things that are located outside of the archive. But, they are semantically related to one or various archival sources in an immediate manner. Intangible objects, by contrast, would be mental processes or actions, which are comprehended in the form of design ideas or a research theory, but also journeys or correspondences are, however, ontologically alienated. The reference of an archival source to one of these tangible or intangible objects is a particular challenge for the web application. But, in our proposal of technical solution strategies, we exclusively consider tangible objects.

***Example** – The example of the sketch previously brought in hardly contained qualitative information by itself. Against this background, a concrete statement about its contents could only be made then when its individual messages are interrelated to the ones of other archival sources (in this case, it was a sketchbook and an attached list of architectural objects). This cognitive process accomplished in the analogue archive was not limited to the joining of similar tangible, formal or semantic messages from the same ontological domain, but also referred to the inclusion of an external physical entity, located outside of the archive, in this case to a depicted architecture in Tuscany.*

The observation of cognition processes that deal with archival sources during our research project clarified that the "cognition radius", depending on the expertise, is, in parallel, always expanded by ontologically strange or alienated domains. The bridging of these different knowledge domains requires one or several references that ensure the traceability of considerations and cognition processes. That is why the bridging should also be possible in the web application. Against this background, we faced up to two distinct reference models, one by *William James* and the other by *Bruno Latour*. We incorporated both of them into the method of presentation applied in the web application.

In the view of the American philosopher and psychologist *William James*, a contemporary of *Geymueller*, reference is to be regarded as intermediation of conformities. This intermediation depends on a) facts, b) relationships with ideas, and c) accordance with other truths which would be assessed with regard to the recent utility [17]. Whereas *Bruno Latour* does not consider a reference as a correspondence between the archival source and an object that ontologically differs from the source, but as a feature of a chain of several transformational steps. In his view, the feature (reference) circulates on the chain [18]. He did not try to establish a direct connection between the ontological domains of 'language', 'mind' and 'thing', but to consider those transformational steps that are neglected in *James'* model. However, in *Latour's* view, those are of significance due to losses of conformity that can occur because of them.

***Example** – Like it is recognisable by the sketch, there were continuously contextual changes in the course of the sketch's life, starting from the place of emergence up to the place where it is stored today. Thereby, material/matter, form and/or content of the action originally intended by Geymueller transformed multiple times* [19].

According to *James*, the sketch shows content-related conformities with its model. These conformities constitute a reference between the model and *Geymueller's* idea. Having regard to other archival sources and the performances of its individual messages (*the number invoked on it and the sketchbook including the list deposited*), a concrete content-related conformity with an object located outside of the archive can be reached. This conformity, however, requires a complex cognition and is not possible without knowing other archival sources.

By contrast, according to *Latour*, the sketch does not depict the architecture, but only represents one (or maybe also several) of *Geymueller's* ideas about it. Thus, the sketch does not exclusively represent architecture or ideas, but both of them. It implies the architecture as a 'thing' and *Geymueller's* 'mind' then, as well as the beholder's 'mind' today. According to this, the reference contextually moves on a thread of coincidentally reducing and amplifying steps of cognition [20]. The latter can turn to both directions, to *Geymueller's* thoughts, on the one hand, and to the thoughts of the beholder, on the other hand. That is why the sketch does not show a clear reference, but it is *"a directionality operator that is only insofar faithful as it allows the transition between what precedes and what succeeds"* ([18]: 82); translated from German to English by the paper's authors).

This consideration finally brought us to the question of what is the prior immediate relation to the sketch and what is the afterwards. From this resulted the assumption that, in the case of architecture-related archival sources, the third value of the message quality cannot be accomplished contextually independent. And, in the case of ontologically distinct domains, conformities (*James*) as well as gaps (*Latour*) can appear. What prevails always depends on the local or temporal contexts as well as on the tangible, formal or content-related transformational step between the archival source and the preceded or the subsequent one.

Example *– The sketch itself does not stand for a semantically qualitative message and is without cross-linking to other archival sources or external objects only a pure aesthetic artefact. It is one of several operators of a chain of transformational and / or cognitive steps, whose advent is neither the exemplary architecture drawn in 1865 and its end, nor today's classifying interpretation. The sketch is part of a greater whole, whose cross-linkages among each other circulate, depending on the issue* [21].

Results – It became apparent that the source as a single information and the archive as a comprehensive information are mutually dependent. On the one hand, the message quality of an archival source is dependent from the systemic layout of the archive. On the other hand, the overall message of the archive also depends on the message qualities of the individual archival sources. Deficits regarding the semantic communication can thus be attributed to the access and the classification scheme of the archive (possibility of cognition) as well as to the missing message qualities of the sources (possibility of messaging).

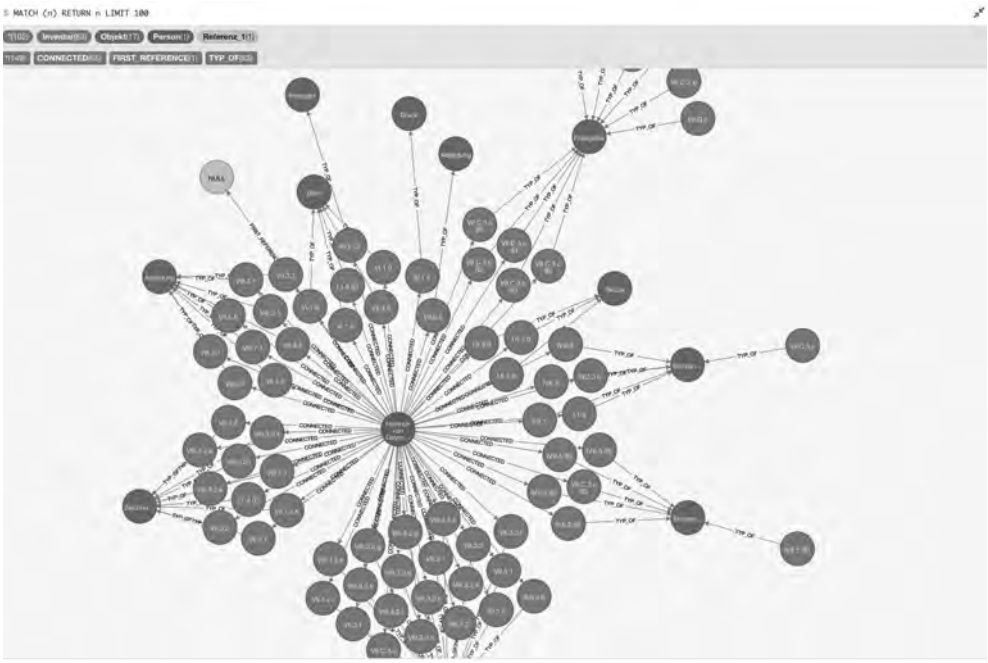

Fig. 3. Network graph – Neo4J realtionship Browser. (Author)

Our definition of a message quality contains therefore a third message value: the interconnection of an archival source and its knowledge domains that are located outside of the archive. Relationships to real objects and actions that are located or take place outside of the archive are to be regarded as an extension of the consolidation of individual messages (features). They are treated according to the way they already were presented within the archive by means of an archival source (see III. A.) as well as several archival sources to each other (see III. B.). These external relationships could, for example, matter between:

- an archival source and another source (of another archive, collection, publication) [ontologically similar],
- an archival source and a physical entity (tangible artefact, natural object, person) [ontologically different],
- an archival source and a mental process or actions (intangible design ideas, research theory, journeys, correspondences) [ontologically alienated].

While preparing the web application, we thus faced the challenge to be able to change the chain's order of the classification assigned to the archival source in the analogue archive. Therewith, we were also able to determine the respective objects adjacent to the archival source in order to establish immediacy in the relationship between them. This also applies to the relationship between the source and an external tangible or intangible object. The final goal of this function is the consolidation of individual information.

The implementation of different XML-based standards (Iconclass, DublinCore, etc.) supports the linking of single archival sources with other objects, as for instance with sources of other archives or publications or physical entities. But, XML-based standardisation is only a formal description of the data structure, which is a problem. Data exchange has to be programmed separately for each archive. According to that, the origin of this problem is the hierarchical structure of XML documents. The 'common authority file' (in German: Gemeinsame Normdatei, short form: GND) encompasses, for example, all entities and is a clear reference frame for bibliographic data of libraries, archives, museums and the like. We propose, therefore, to interlink the archival sources with objects outside of the archive, in urban areas for example, by using the method of geotagging.

IV. CASE STUDY

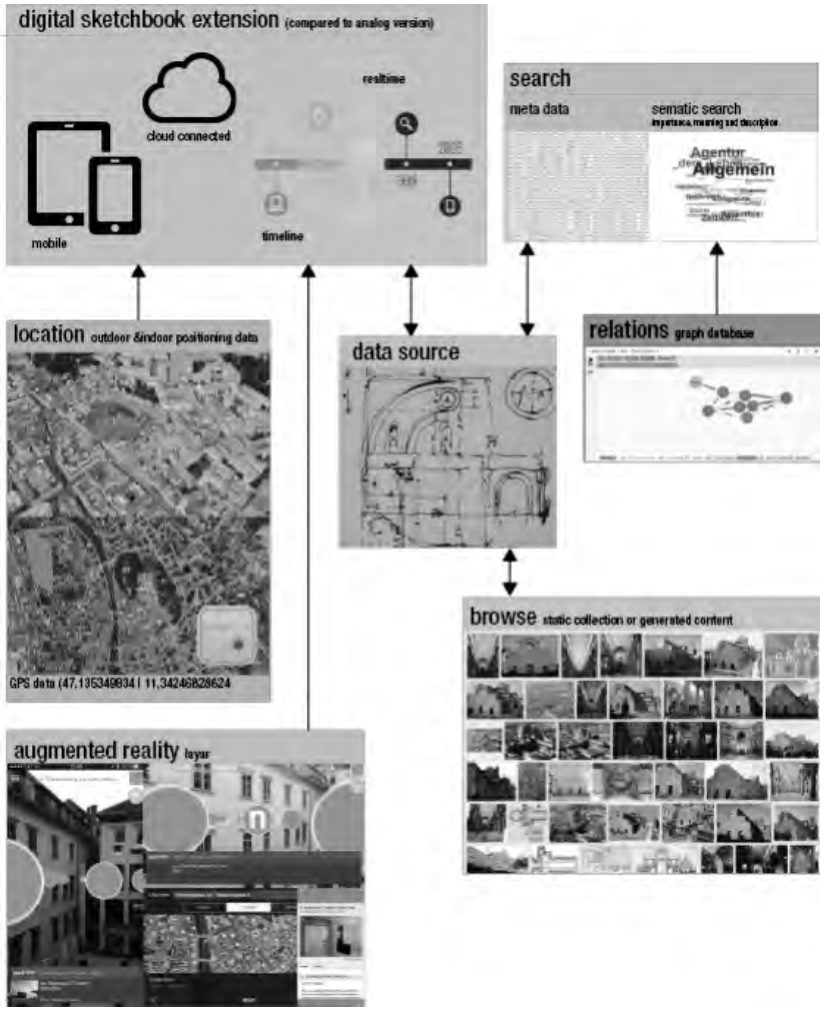

Fig. 4. Conceptual diagramm and application mockup. *(Author)*

The Semantic Web (Web 3.0) provides a fundamental data structure and also the principles of usage necessary for this project. It is a web technology that liaises different information from the browser's search query. It relates them and their connections to each other and evaluates them for their meanings. The aim is to improve the communication between human and computer (human-machine interaction) and achieve higher quality, as well as more significance in the search results. The user formulates an exact enquiry, which is allowed or denied by the web standards. The result viewerserves then the expectable search result on the web. The personalisation of content on the Internet is associated with this new development. New personalised web services simultaneously save the user's behaviour and habits. This extension of the World Wide Web provides data that could be easily evaluated, read by machines and interchanged with other web sources.

IV. A. Location/geotagging

Image data is the most prominent example for this application. This kind of data generation is an efficient form of including site-specific data. As already mentioned, not only photos can be located by means of geotagging, but also other data. This gives us the opportunity to manage site-specific data. The Geospatial Semantic Web accommodates itself excellently to this project, as the 'loose' data structure of the provided data model shows. This enables the provision of a flexible environment for applications that are outside of a pure site-specific model, in which geodata are blended or complemented with native data.

GPS data in a reasonable resolution are currently only offered for outdoor spaces. Localising indoor spaces has already been at the centre of technological developments for quite some time. For example, *Google* has implemented the 'function indoor' since 2011 and allows the user also to navigate inside of the building (e.g. in shopping malls). Moreover, with the 'project glass', *Google* promised 2013 an indoor 'navigation' by using its augmented reality glass. Further projects like 'IndoorAtlas' [22] or the 'Indoor Survey' [23] of *Apple* also strive in the direction of precisely positioning people indoors (even though these technologies are only provided in commercial facilities that have more than one million customers per year). The technologies for these applications are based on 'Mesh Networks' [24], active iBeacon Networks as well as Inertial Navigation and algorithms that run on image recognition. All of them are premised on radio frequency identification (RFID) [25] and near field communication (NFC) [26].

IV. B. Semantic Database Solution – The reference-plane model

The allocation is independent from its genre and orientated not only via form or materiality but also through semantics and performances in connection with other archival sources. The distinction of tangible or intangible objects [27] is essential while working with archival sources which are not referring to an implemented or medial object (e.g. archival source in a different archive), as we had to deal with very often in *Geymueller`s* legacy.

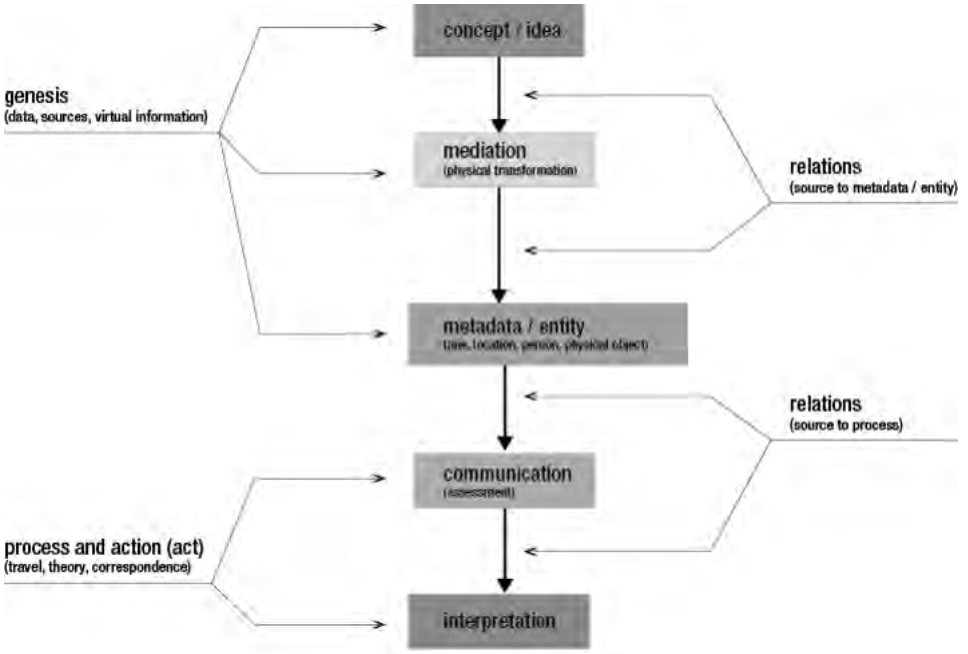

Fig. 5. Reference-plane model as a semantic database solution. *(Author)*

The aim of the database is a parallel reference of at least one tangible and one intangible reference. The performance of semantic characteristics of an archival source is described, according to their reference, in its performances *portraying*, *reconstructing*, *illustrating* or *mapping*. Besides, the 7 interpretation of the representation remains completely open. This subordinate level refers to those topics, concerning the sources, which are already published. Based on archival sources (image, text, hybrid) they are interconnected with metadata and Thesauri/glossaries. As a result, we gain connections to other databases and a data standardisation. We assume the interconnection of metadata and different reference planes in our data model. Those are organised hierarchically. Moreover, they expand the metadata by other sources (e.g. materialisation and idea or communication and interpretation) and relations that interconnect with intangible characteristics, such as processes and acts.

IV. C. Browse – Web application enables browsing and rummaging on site

Bibliotheca Hertziana' [28] and the digital collection of the 'Schloss Belvedere', the Belvedere Palace, are already two digital archives that pursue the same approach we have chosen ('rummaging and finding') [29]. Visitors are introduced to the archival stock through compilations and collections. This conforms to the idea of the 'semi-digitally generated sketchbook', which is the starting point for further research on the object. While compilations in the Belvedere's collection are still produced by archivists, we can generate collections automatically by means of search queries.

IV. D. Augmented Reality [30]

We use this application not only to ensure localisation, but the site-specific presentation of data as well. The web app, and the users, access information on site or link it to the site. The user receives further digital information in real-time, which are presented on a semi-transparent level. Consequently, the recent knowledge is overlaid with related topics, similar information, and consecutive aspects.

Besides the widespread GPS based systems like 'Layar' [31] or others [32], there are also technological alternatives available in this area. For example, spaces or objects can be overlaid with particular visual markers (e.g. QR codes [33]) or systems based on image recognition [34]. Modern augmented reality hardware like 'Oculus Rift', 'HoloLens', 'Cardboard VR', etc., makes use of these technologies. Moreover, there is already hardware on the market, which recognises spatial conditions, like a room's edges and corners, and which operates with [35] or without [36] subsidiary active systems of space measuring (visual laser net).

IV. E. Cross-linking an archival-source to urban space and its people

Two essential aspects of modern information technologies accompanies the connection between an archival source that it is older than 150 years and today's urban place, where it has been recorded:

1. The digital archive source can be easily taken everywhere. This makes improvements possible in terms of comparisons with physical entities of urban places today, such as search options and networking with other archival sources.
2. The search is not limited to metadata and descriptions but expanded by relations between the archival sources, which we define as a precursor for the semantic search.
3. In a semi-digital prototype version new sketchbooks are generated from the specific search entry. The sketchbooks then contain a compilation of archival sources from *Geymueller's* archive as well as from other archives, which serve as a starting point for further scientific processing.
4. A semi-analogue sketchbook has the disadvantage that the data from archive-sources and the archive itself can be created only at a specific point in time. In addition, new information that is developed by researchers can only be reintegrated into the archive by digitalisation.
5. Through a digital sketchbook (as web app on a tablet or smartphone), information, sketches, photos, and descriptions can be assigned directly to the archive and the existing archival sources (see 1.). It is possible in this project to use the web app for relationships, as the technical implementation (such as graph data with RDF triplets) has no limits (such as the implementation in classical, relational modelled databases).

The archive can thus be expanded in real time. In the analogue archive there have often been comments left on archival sources by its scientific users. Concerning the web application, however, these comments should be saved on different layers so that other users can decide independently on their presence.

Results – Within the resulting reference-plane model there is no distinction between image and text based data, but the hybrid sources are included. We identified several technologies for the reference-plane model to be outlined in an application prototype. Moreover, for the web application in the *Geymueller* project, we suggest to use WebVR 1.0 that is present as a beta version in the Chromium browser and also one of the GPS based VR frameworks mentioned above. Finally, there is an existing mock-up to be tested in the field. This mock-up includes state-of-the-art representation of archival material in museums and is also scheduled to be tested in historical urban areas.

V. CONCLUSION

The basis of the presented strategy is the data model, which has been developed in the 'Geymueller' research project. This model enables the interlinking search of archival sources not only by its metadata (material, formal and content) but also by the performances of the content's features. Here, the challenge was to relate the linkages of standardised metadata to semantic messages.

A further part deals with the contextualisation of the archival sources and urban places. Contexts are tangible and intangible objects. It is about relating them to external fields of knowledge by using the method of geotagging. Through the usage of geotagging as a method, we achieved interlinking of the archive data with urban spaces and after that provided this information for online users. To accomplish our goal, we have to prepare the analogue sources as they are either text-based, and image-based, or hybrid sources which need – after being translated into equally searchable data – to be adapted and presented in the Word Wide Web. As mentioned in the discussion section, we were able to find suitable solutions for all difficulties and to find suitable solutions. The results point out that we are definitely able to connect searchable archive data in an appropriate way and display them in an online-archive.

The previous discussion shows the broad spectrum of conventional archival work and its challenges by using digital methods based on semantic data structures. With our attempt to reference original archive sources to the location and to present them through a user-friendly interface, we are able to show valuable connections between tangible and intangible objects on the Internet.

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[9] Tangible, formal and semantic features of an archival source are referred to as 'messages' in the following.

[10] A tangible object is an entity like a thing, a person, a space, an artefact, etc. Whereas an intangible object is a process or action, for example like an outline, an idea or a research intention, can also be a journey or communication etc.

[11] In order to better understand *Geymueller*'s methods from an intellectual historical perspective, we considered theories of cognition from the late 19th and early 20th century. These theories were of particular importance with regard to the reconstruction of his project 'Thesaurus of Architecture', a large-scale project, that intended to compare all kinds of architectural depictions like drawings, plans or models from various collections. The comparison should be presented in a continuous series of publications [Ploder, J. (1998). *Heinrich von Geymüller und die Architekturzeichnung: Werk, Wirkung und Nachlaß eines Renaissance-Forschers*, Wien: Böhlau]. The project could not be realised due to financing problems, even though it comprised, for this time, an enormously progressive research approach. With regard to the ideas presented in this paper, we should go on thinking about this approach.

[12] Ehrenfels, von, Ch. (1890). *Über Gestaltqualitäten, Vierteljahrsschrift für wissenschaftliche Philosophie.* (14), Berlin: unknown, pp. 249–292. *Ehrenfels* named this model 'gestalt quality' und pointed out the example of melody: A melody consists of individual tones. If these tones are transferred to a different key, the tones condition the melody. *Wolfgang Koehler, Kurt Koffka* and *Max Wertheimer* later refined this approach [Norberg-Schulz, Ch. (1965). *Logik der Baukunst*. Berlin: Ullstein, pp. 28–34.

[13] Unlike in a melody, it is not compelling that the order of individual messages of an archival source is always the same.

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[16] Kind of labelling, formal similarities of the sketches as well as conformity of the numbering at the top right margin and the one on the list.

[17] James, W. (1975). *Pragmatism. A New Name for Some Old Ways of Thinking*. Cambridge/MA: Harvard University Press, pp. 205–244. *James* is considered the most significant representative of the 'pragmatic philosophy'. His theory of truth is shaped by conformities, in a relativistic way, as well as by an utilitarism, by which he tried to especially distance himself from rationalism prevailing in his day.

[18] Latour, B. (2002). *Die Hoffnung der Pandorra: Untersuchungen zur Wirklichkeit der Wissenschaften*. Cambridge/MA: Harvard University Press, pp. 84–87.

[19] Thus, references changed. This also applies to the semantic conformities, which probably have changed for Geymueller, too, by pulling the sketch out of the sketchbook and assigning it to another topical context. In this case, the new context is not only focussed on the architectural form, but on the entire stylistic disposition of Renaissance in Tuscany. Superficially, for Geymuller, it was not only a matter of depicting a model, but of the tendential process of stylistically disseminating. In the individual consideration, he occasionally could notice the latter with regard to this architecture.

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[27] An intangible object is descendent from a ontological concrete field and is defined via entities - likewise artefacts, things, rooms or people. This object originates in an ontological mental/intellectual area, and is either defined through a cognitive process or an action. It can for instance rely on what ist called the `concept` (concetto) by the architecture theoretician Giorgio Vasari (1550/1568) - an artifacts underlying idea. She is put into reference to a source object for example, if it refers to an intellectual concept - e.g. a research intention, a design idea or a theoretical reconstruction. The source genres generally most affected are sketches, charts, drawings, reconstruction plans, but also letters and notes, which are linked via content from a journey, fro ma conversation, an idea oder any other cognitive process.

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Does the human brain really like ICT tools and being outdoors? A brief overview of the cognitive neuroscience perspective of the CyberParks concept

Michal Klichowski
Catarina Patrício

Abstract – *The paper presents an overview of the latest studies on cognitive neuroscience that can help evaluate concepts that promote technologically-enhanced outdoor activities, such as CyberParks. The following questions are asked in the paper: does the human brain really like ICT tools? Does the human brain really like being outdoors? And finally: does the human brain really like technologically-enhanced outdoor activities? The results of the studies presented show that the human brain does not like ICT tools yet, it likes being outdoors very much. At the same time, it was shown that outdoors activities may be encouraged by ICT tools, yet outdoors activities themselves should be free from ICT tools. Using ICT tools and physical activity at the same time is a dual task, a type of activity that leads to cognitive and physical processes being destabilised, which leads to weakened effects of both cognitive and physical tasks. From the perspective of cognitive neuroscience, CyberParks are not a solution that the human brain really likes. Another issue is also discussed, namely: do technologically-enhanced outdoor activities—such as in CyberParks—really increase the quality of life?*

*K*eywords—**quality of life, ICT tools, outdoor activities, technologically-enhanced outdoor activities, human brain, cognitive neuroscience**

I. INTRODUCTION: FROM CLASSROOMS WITH LINKED COMPUTER TERMINALS TO CYBERPARKS

It is commonly assumed that information and communication technology tools (ICT tools) have a great impact on the quality of life. In the debate on the relationship between ICT tools and the quality of life, the topic of education is extensively covered. As many researchers claim ([1], [2], [3], [4], [5]), ICT tools not only enrich teaching and learning activities, but also condition the quality of today's education. Salehi, Shojaee and Sattar [6] even assume that the introduction of ICT tools to education is absolutely necessary for living in the contemporary world. ICT tools ensure twenty-first century skills ([7], [8]) and "create a bridge between students' needs and expectations and labour market demands" [9].

Without doubt, the growth of ICT tools has dramatically reshaped education [9]. The process of these transformations started as early as the beginning of the 20th century when the first video films (starting in the 1900s) and Pressey's mechanical teaching

machines (starting in the 1920s) were introduced at schools. However, it was not until the year 1960 that a true breakthrough happened and the era of ICT tools in education started. It is when researchers at the University of Illinois created the first classroom system based on linked computer terminals. The same year saw Suppes and Atkinson conduct experiments on the influence of working with a computer on the process of reading and learning math by children in California. Three years later Luskin installed the first computer in a community college. In the years 1970s-80s Turoff and Hiltz developed computer-based learning programmes at the New Jersey Institute of Technology. In 1976 Luskin—using the KOCE-TV television station as a vehicle—launched the Coastline Community College as a "college without walls". In the mid 1980s, distance learning courses using computer networking started to emerge, as well as ideas such as computer-based training (CBT), computer-based learning (CBL), or even e-learning systems in an embryonic form based on computer supported collaborative learning (CSCL). In 1990, the process of using the World Wide Web to create fully autonomous learning and teaching environments started, and as early as in 1994—barely 34 years after the first classroom system based in linked computer terminals was created—the first online school was founded [11].

The beginning of the 21st century is a period of the global full bloom of the strategy for educational applications of ICT tools, which is exemplified by the incredible development of e-learning, m-learning and u-learning. What is considered to be the most advanced stage of changing education through new ICT tools, however, is currently smart education ([12], [13], [14], [15], [16], [17]), a concept of resting education on ICT tools to the maximum ([18], [19], [20]), particularly on: mobile computing ([18], [20], [21]), digital textbooks ([14], [15], [22]) and cloud computing ([14], [15], [19], [23], [24], [25], [26]).

CyberParks are supposed to be one of the innovative instances of smart education, understood as open public spaces (i.e. a park, garden square, plaza, etc., or a natural space inserted in an urban setting, or an urban forest, a protected landscape, etc.) with an augmented digital dimension. CyberParks strive to transform public spaces into interactive and immersive learning environments (outside curriculum or extended school studying) capable of increasing social, communicative, and possibly collaborative skills. In simple words, CyberParks are meant to be a space for technologically-enhanced outdoor activities ([27], [28]). What is more, CyberParks are considered a technological response for new standards in education (that are at the same time an element of cultural trends in improving the quality of life) such as: nature-based and whole-body learning or learning experiences in an outdoor setting [29].

However, do CyberParks as spaces for technologically-enhanced outdoor activities indeed become a concept for improving the quality of life of the contemporary human? In COST Action TU 1306[1], over 80 researchers from 30 countries make an attempt at providing an

[1] European Cooperation in Science and Technology Action: *Fostering knowledge about the relationship between Information and Communication Technologies and Public Spaces supported by strategies to improve their use and attractiveness (*CYBERPARKS) (TUD COST Action TU1306): http://www.cost.eu/COST_Actions/tud/TU1306; http://cyberparks-project.eu.

answer to this question by conducting interdisciplinary analyses of the social, academic and educational sense of the CyberParks concept. This paper shall present one of the perspectives of these analyses: the cognitive neuroscience perspective. Developing this perspective seems very important, because in spite of a large inflation of publications on brain-based learning and brain-based education ([30], [31]) a gap between neuroscience and educational practice still exists, which is confirmed by numerous studies [32]. Thus, this paper shall attempt to answer the following questions: does the human brain really like ICT tools? Does the human brain really like being outdoors? And finally: does the human brain really like technologically-enhanced outdoor activities? The attempt shall be based on the review of the latest literature resources on cognitive neuroscience [33]. Presenting the cognitive neuroscience perspective of technologically-enhanced and outdoor activities may become an interesting point of reference for further works related to the development of the CyberParks concept and encourage a debate on the crucial issue: do technologically-enhanced outdoor activities, such as CyberParks, really increase the quality of life?

II. DOES THE HUMAN BRAIN REALLY LIKE ICT TOOLS?

The socialisation influence of ICT tools on the contemporary human is of such common and global character that ICT tools are more and more frequently introduced in human development models as one of its key determinants. It would seem that the most evident example of this type of change is the new version of one of the most important human development models, i.e. Bronfenbrenner's model of the ecological systems theory (this model assumes that human development occurs in four overlapping ecosystems: microsystem, mesosystem, exosystem and macrosystem). It was built by Johnson and Puplampu by creating a new dimension of the microsystem (according to Bronfenbrenner, a microsystem covers individual experiences gathered in the closest environment): the ecological techno-subsystem [34]. The ecological techno-subsystem includes a person's "interaction with both living (e.g. peers) and non-living (e.g. hardware) elements of communication, information, and recreation technologies in immediate or direct environments" [35] (see figure 1).

Many studies are conducted that aim at defining the effects of creating techno-subsystems [36]. One of the scopes of these studies encompasses neural effects of ICT tools use, and is thus linked to research on the changes caused by ICT tools in the human brain. This field, however, is not particularly popular in cognitive neuroscience; as a consequence we still know very little about the neural effects of ICT tools use (quite contrary to what we know about the neural correlates and neural effects of non-ICT tools use, as this field boasts very reliable knowledge ([37], [38], [39], [40], [41]). Nevertheless, cognitive neuroscience does formulate some stipulations that cast some light on the issue.

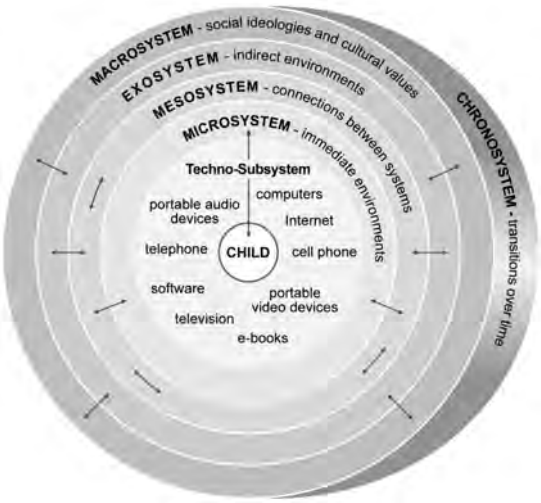

Fig. 1. Johnson and Puplampu found a new dimension of the Bronfenbrenner's model of the ecological systems theory. This model assumes that human development occurs in four overlapping ecosystems: microsystem, mesosystem, exosystem and macrosystem. According to Johnson and Puplampu (2008), in contemporary times the microsystem should be expanded with the ecological techno-subsystem. This subsystem includes ICT tools and shows how strong and common its socialisation influence on the contemporary human is. Source: G.M. Johnson, and K.P. Puplampu, "Internet use during childhood and the ecological techno-subsystem," Canadian Journal of Learning and Technology, vol. 34, no. 1, 2008. Under the terms of the Creative Commons Attribution License.

For instance, researchers ([42], [43], [44], [45]) quite agree that ICT tools use changes the way of thinking or even leads to the creation of a new structure of thinking, or, simply, that ICT tools change in a sense the human brain. What does that mean? According to de Kerckhove [46], under the influence of ICT tools people acquire the ability to quickly search through reality and learn through cooperation, yet they also lose the habit of linear (quiet and ordered) thinking and begin to think in a quick and careless, even chaotic, way, as if they were clicking links on a website without any plan.

De Kerckhove's thesis is confirmed by the results of several studies. For example, Hadar et al. [47] studied cognitive changes and brain activity changes associated with smartphone usage. The participants of this study were 38 healthy adults lacking any previous experience with smartphones (nonusers) and 17 healthy adults classified as extensive smartphone users. It turned out that extensive smartphone users obtained significantly lower accuracy rates than nonusers in the information processing task. Further analyses with the use of electroencephalography (EEG) and transcranial magnetic stimulation (TMS) indicate lower prefrontal long-interval cortical inhibition (LICI) in extensive smartphone users group as compared with nonusers. What is more, in the second part of the study the researchers divided nonusers into two groups: an experimental group, that started using smartphones, and a control group (that continued not to use smartphones). After three months it was found that the participants from the experimental group experienced a significant decrease in information processing capacity (whereas the effect did not occur in the control group).

On the other hand, Loh and Kanai [48] found that media multitasking, i.e. simultaneous use of many ICT tools (e.g. computer and TV) and simultaneous use of ICT tools and carrying out other activities (e.g. using a smartphone while walking) negatively affects the human brain. Researchers calculated the Media Multitasking Index (MMI) of 70 volunteers (healthy adults) and then examined them with the functional magnetic resonance imaging (fMRI) method. It turned out that participants with a higher MMI had smaller gray matter density in the anterior cingulate cortex (ACC) (see figure 2). ACC serves as a crucial nexus of information processing pathways in the human brain, thus smaller gray matter volumes in the ACC may cause poorer cognitive control performance and worse effects of learning.

It is worth adding that several studies ([49], [50]) show that using ICT tools may still have a positive influence on the improvement of cognitive skills such as memory and attention in older adults. What is more, other studies show that ICT tools may also positively influence brain functioning in people with brain dysfunctions [51].

Gindrat et al. [52] found that the very use of a smartphone understood as a touchscreen phone and consisting in clicking on a flat screen with fingers irrespective of the type of the task carried out changes the human brain. These researchers used the electroencephalography (EEG) method to examine 37 right-handed volunteers, 26 of whom used touchscreen phones and 11 of whom used old-technology mobile phones (with a standard keypad). They measured the cortical potentials in response to mechanical touch on the thumb, index, and middle fingertips. It turned out that the participants who used smartphones processed tactile stimuli in a completely different way than old-technology mobile phones users. A detailed analysis of the EEG record shows that touchscreen phone use reorganised the representation of the fingertips in the somatosensory cortex. It is thus another interesting piece of evidence for the plasticity of the somatosensory cortex, one that can, however, cause considerable anxiety. Indeed, the plasticity of the somatosensory cortex is thus associated with the development of chronic pain, and as several studies uncovered there is a correlation between excessive phone use and motor dysfunctions and pain. For instance, Berolo, Wells and Amick [53] found significant associations included the total time spent using a mobile device and pain in the right shoulder and neck. It is thus probable that the reorganisation of the somatosensory cortex caused by intensive touchscreen phone use correlates with the development of chronic pain (for example in the right shoulder and neck).

It is worth adding, however, that the study conducted by Kretzschmar et al. [54] with the use of the electroencephalography (EEG) method and eye tracking shows that in the context of processing a written text there is no difference in what reading devices we use (a paper page, an e-reader or a tablet computer). These researchers therefore suggest that the overwhelming public opinion that digital reading media, though convenient, change the processing of a text is a cultural rather than a cognitive phenomenon. As Asakawa et al. [55] found, a similar state of affairs occurs in the context of photographs, i.e. irrespective of whether they are printed out or displayed on the screen of an electronic

device, they cause analogous changes of emotions. The negative influence of ICT tools on the human brain applies not so much to the use of ICT tools itself, but rather to the type and intensity of an activity. Thus, using ICT tools for activities such as reading and browsing through photos should not be correlated to negative changes in the human brain.

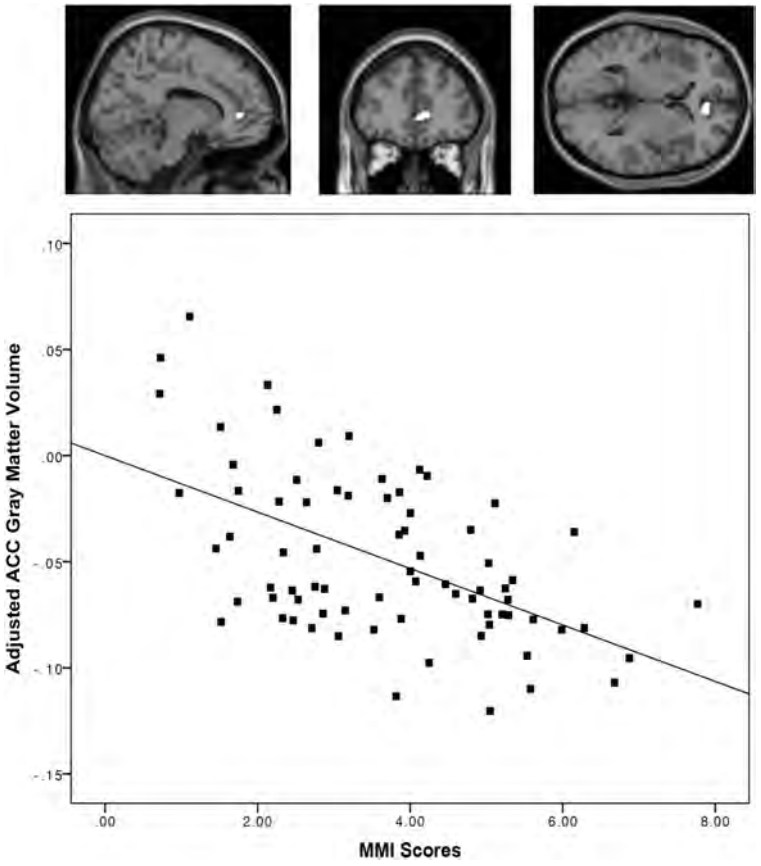

Fig. 2. Loh and Kanai found that media multitasking negatively affects the human brain. Participants with a higher Media Multitasking Index (MMI) had smaller gray matter density in the anterior cingulate cortex (ACC). MMI scores are thus significantly associated with gray matter density in the ACC. Source: K.K. Loh, and R. Kanai, "Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex," PLoS ONE, vol. 9, no. 9, pp. 1-7, 2014, doi: 10.1371/journal.pone.0106698. Figure 1 doi:10.1371/journal.pone.0106698.g001. Under the terms of the Creative Commons Attribution License.

At the same time, many researchers claim that the human brain "likes" ICT tools. Why is that? Most frequently, without reference to reliable results of experimental studies, they underline that people learn most efficiently through novel stimulus and challenges, and ICT tools provide them with ceaseless novelties and challenges [30]. The latest studies ([56], [57], [58]) do not, however, confirm this observation. It is because ICT tools become an attractive tool for learning only for those individuals who are cognitively playful, i.e. for people for whom most tools available have cognitive potential.

As the results of the latest studies in cognitive neuroscience suggest, ICT tools may negatively affect the human brain. Furthermore, the commonly accepted statement that all students and young people develop better when they use ICT tools seems untrue. It would thus seem that the human brain not always (or even: very seldom) really likes ICT tools.

III. DOES THE HUMAN BRAIN REALLY LIKE BEING OUTDOORS?

ICT tools are often perceived as a kind of panacea for all the maladies of education. Many problems occurring at schools around the world are attempted to be solved through investments in ICT tools. To a large extent, modern curriculum designs describe the best learning environments as technology-based classroom learning environments ([59], [60]). However, studies do not confirm any positive correlation between students' progress and the level of implementation of ICT tools in education. Quite the contrary, many studies show that changing a technology-based learning environment to an outdoor (nature-based, authentic, experiences etc.) learning environment, considerably stimulates the effectiveness of learning (for a brief review of this problem, see: [59]).

Outdoor learning is also perceived as a brain-friendly learning environment. It is assumed that being outdoors stimulates the most effective forms of learning such as learning through physical and multisensory activity [30], and at the same time supports maintaining mental health [61]. For example, studies indicate that the more time children spend outdoors, the more physically active they are (1 hour outdoors equals to approximately 27 minutes more of physical activity) and that the closer children live to an area with more natural surroundings, the less psychological distress they feel [62], as well as that, moving the classroom to forest at least once a week improves pupils' mental health considerably [63].

Being outdoors also stimulates attention, improves cognitive processes and encourages learning. The open space does not, however, lead to an excessive use of the brain's energy that would otherwise create cognitive fatigue, but actually encourages a sense of cognitive clarity and removes confusion ([29], [64]).

Volta et al. [65] found that during physical activity in the open space, greater activation occurs in the human brain, as compared to a narrow space. The researchers used the methods of functional magnetic resonance imaging (fMRI) and rolling cylinder. Laying down in an fMRI scanner, 17 participants took a walk (through a rolling cylinder) watching two films: an open-space video clip that showed a countryside view, and a narrow-space video clip that showed a narrow corridor. It turned out that greater activation in the primary visual cortex (see figure 3) occurs while processing the open space as compared to the narrow one. The open space includes more different elements (grass, road, houses, street lamp, mountains, and so on) than the narrow space, thus processing this space stimulates cognitive activity more ([66], [67]). In short, physical activity outdoors has a considerably higher potential for cognitive processes than indoor physical activity.

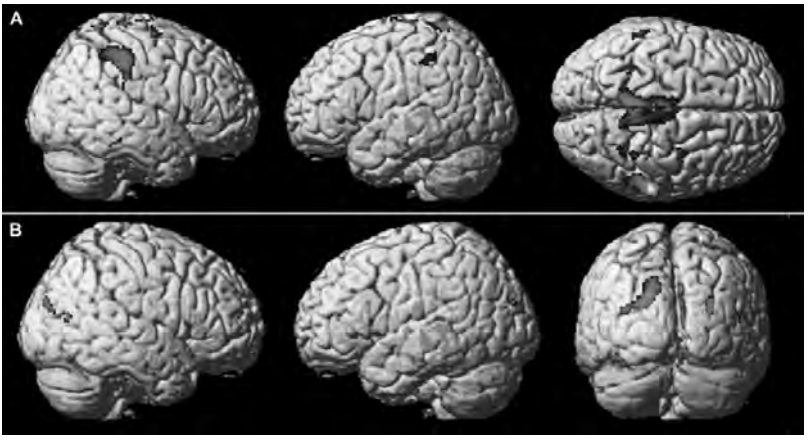

Fig. 3. Volta et al. found that (A) while processing the open space greater activation in the primary visual cortex occurs (B) as compared to the narrow one. The open space includes more different elements (grass, road, houses, street lamp, mountains, and so on) than the narrow space, thus processing this space stimulates cognitive activity more. Source: R.D Volta, F. Fasano, A. Cerasa, G. Mangone, A. Quattrone, and G. Buccino, "Walking indoors, walking outdoors: an fMRI study," Frontiers in Psychology, vol. 6, 2015, doi:10.3389/fpsyg.2015.01502. Under the terms of the Creative Commons Attribution License.

Shin et al. [68] found, however, that not every type of open space stimulates cognitive processes positively. The researchers analysed the cognitive effects of a walk through a pine forest versus downtown streets. One day, participants took a 50-minute walk in a forest, and another day a walk of the same length in a city. Before and after each walk they underwent cognitive and mood assessments. It turned out that the walks in the forest caused much better mood improvement than the city walks. What is more, only after walks in the forest participants' cognition was observed to improve. Similar results were obtained by Weinstein, Przybylski, and Ryan [69]. They also indicate that immersion in natural environments correlates positively with the fulfilment of psychological needs. On the other hand, Nisbet and Zelenski [70] found that outdoor walks in nearby nature increase the feeling of happiness.

In a meta-analytic study, Cassarino and Setti [71] show, however, that in some studies the city activity's positive influence on cognitive processes was noticed, e.g. on the ability to focus attention. Yet, this positive increase is always positively correlated with the cognitive load and many disturbances in the process of scanning the environment.

As suggested by the results of the latest studies in cognitive neuroscience, being outdoors, close to nature, may influence the human brain positively. It seems therefore that the human brain almost always really likes being outdoors.

IV. DOES THE HUMAN BRAIN REALLY LIKE TECHNOLOGICALLY-ENHANCED OUTDOOR ACTIVITIES?

Knowing about the beneficial influence of physical activity on our health—physical and mental—attempts are made at creating ICT tools that will encourage physical activity [72]. Many studies show that indeed ICT tools may stimulate activities. For example, Lubans et al. [73] found that a smartphone application called ActiveTeen Leaders Avoiding Screen-time (ATLAS) may promote physical activity and—interestingly—reduce screen-time behaviours. What is more, Stuckey, Kiviniemi and Petrella [74] prove that applications of the mHealth type implemented for smartphones can stimulate activities in a way that improves heart rate variability (HRV) by increasing and decreasing high and low frequency powers in normalised units, respectively, which may be incredibly meaningful in the context of diabetes and prevention of cardiovascular diseases. Attempts at combining ICT tools and physical activity can also be exemplified by the already common active video games (AVG) and technologies of the Microsoft Kinect and Nintendo Wii type [75].

There are also several ideas about how to include ICT tools in outdoor activities. Apart from the CyberParks concept discussed in this work, projects that fit the trend of technology-enhanced outdoor learning experiences can be enumerated, for example: Adventure Learning at Taylor Wilderness Research Station, Adventure Learning at Main Salmon River, CreekPlace Summer Camp, Adventure Learning at MOSS (AL@MOSS), YoTeach!: Adventure Learning in a Higher Education Setting (for a brief review of these projects, see: [76]). Nevertheless, it has to be stressed that numerous opposite projects are also created as far as the idea for including ICT tools in outdoor activities which are based on the assumption that for the good of our physical, mental and cognitive health outdoor activities should be freed from ICT tools [29].

Studies in cognitive neuroscience confirm that the above assumption makes sense. For instance, Uhls et al. [77] found that outdoor activities without screens improved preteen skills with nonverbal emotion cues. The researchers organised a 5-day nature camp for 51 preteens. During the camp the preteens were not allowed to use TV, computers and mobile phones. Before and after the nature camp preteens underwent a test that required participants to infer emotional states from photographs of facial expressions (the second edition of the Diagnostic Analysis of Nonverbal Behaviour—DANVA2—was used for this purpose) and videotaped scenes with verbal cues removed (The Child and Adolescent Social Perception Measure—CASP—was used for this purpose). Their results were compared with the results of a control group comprised of 54 preteens who used ICT tools normally. It turned out that the experimental group's recognition of nonverbal emotion cues improved significantly more than that of the control group for both facial expressions and videotaped scenes (see figure 4).

Outdoor activities without ICT tools are thus something of a mental break [29] and improve a human's understanding of nonverbal emotional cues [77]. What is more, cognitive neuroscience calls outdoor activities with ICT tools, such as a smartphone used while walking,

dual tasks, which require an appropriate allocation of cognitive and physical resources to each task. A dual task, i.e. cognitive-motor interference, leads to an overload of central resources, and thus to destabilisation of the course of cognitive and physical processes, whose consequence is the weakening of both cognitive and physical tasks. This is why using ICT tools while outdoor activities increases the risk of a fall and disrupts the processing of the open space. This effect is called dual-task cost in cognitive neuroscience [78].

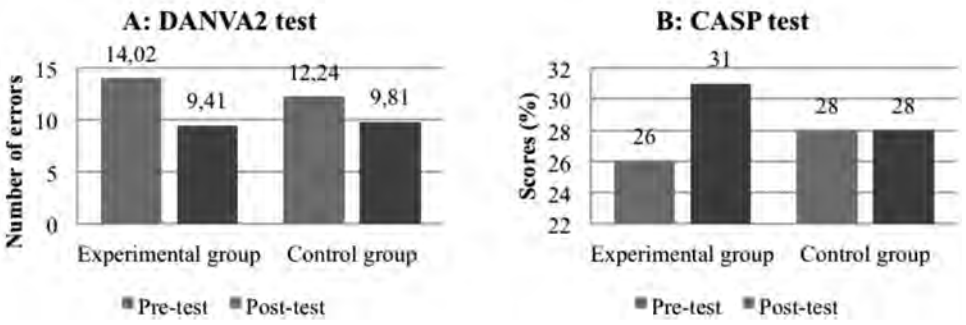

Fig. 4. Uhls et al. found that a nature camp without screens (such as TV, computers and mobile phones) improves preteen skills with nonverbal emotion cues. (A) In the experimental group (that took part in the nature camp), a significantly bigger error reduction occurred from pre-test to post-test in assessing emotions on DANVA2 faces than in the control group (that did not take part in the nature camp). (B) The same effect was observed using CASP: ability to correctly identify emotions of actors was significantly greater for experimental group than for the control group. Source: own work based on: Y.T. Uhls, M. Michikyan, J. Morris, D. Garcia, G.W. Small, E. Zgourou, and P.M. Greenfield, "Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues," Computers in Human Behavior, vol. 39, pp. 387-392, 2014, doi:10.1016/j.chb.2014.05.036.

As the results of the latest studies mentioned above suggest, ICT tools may positively influence the level of outdoor activities and encourage those types of physical activity that have a positive impact on our physical, mental and cognitive health. Using ICT tools during outdoor activities may, however, negatively affect the human brain, and destabilise cognitive, emotional and physical processes. Outdoor activities can thus be stimulated or brought about by ICT tools, yet it is more recommendable for them to occur without ICT tools, as the human brain rather dislikes technologically-enhanced outdoor activities.

V. DISCUSSION: DO TECHNOLOGICALLY-ENHANCED OUTDOOR ACTIVITIES REALLY INCREASE THE QUALITY OF LIFE?

The studies presented show that the human brain rather dislikes ICT tools. Intensive use of ICT tools negatively affects the information processing capacity and reorganises the human brain in a negative way, the consequence of which can be, for example, the development of chronic pain. Media multi-tasking has a particularly negative impact on the human brain. What is more, the cognitive neuroscience perspective shows that ICT

tools can be an attractive learning tool only for a narrow group of people who are cognitively playful.

Being outdoors is a completely different story. The human brain likes being outdoors very much. Being outdoors activates the human brain, improves cognitive processes and is a context for maximally optimum learning. The best form of outdoor activity for the human brain is activity in nearby nature. Immersion in natural environments stimulates the human brain, improves one's mood, improves cognition and increases the feeling of happiness.

ICT tools may encourage outdoor activities, yet they should be free from ICT tools. The simultaneous use of ICT tools and physical activity is a form of dual task, a type of activity that leads to the destabilisation of the course of cognitive and physical processes, which leads to the weakening of the effects of both cognitive and physical tasks.

From cognitive neuroscience's point of view, CyberParks, which are supposed to be a space for technologically-enhanced outdoor activities, are thus not a solution the human brain really likes. Certainly, it is only one of many possible perspectives. It is also worth adding that cognitive neuroscience includes projects directed at the strong development of ICT tools, thus at variance with the results of the studies presented. For example, smartphone applications are created to monitor physical activity [79], smartphones are used in experiments (e.g. in laterality research) ([80], [81]) and called pocketable labs for mobile brain imaging and neurofeedback [82] or portable real-time neuroimaging systems [83]. It is even said that the smartphone technology "presents exciting opportunities for cognitive science as a medium for rapid, large-scale experimentation and data collection" [84]. Furthermore, visions for transforming smartphones into cognitivephones are created where they would monitor and stimulate a human's physical, cognitive and mental health, as well as modify their behaviour or even control their brain [85].

Outdoor activities in nearby nature, for example in a park or forest, seem to be one of the few activities that can still be carried out without ICT tools. What is more, while outdoors in nearby nature the human brain can function optimally and relax from the overburden resulting from the use of ICT tools. Thus, should the attempt at combining technology tools and nature be supported? Do technologically-enhanced outdoor activities increase the quality of life? To answer this question—and as a means to conclude this paper—it is worth recalling the message of the famous essay written in 1928 by Benjamin and titled *To the Planetarium*.

At the beginning of the essay [86], Benjamin remarks: "Nothing distinguishes the ancient from the modern man so much as the former's absorption in a cosmic experience scarcely known to later periods". What Benjamin resonates about is that the cosmos was enacted for the first time on a planetary scale, through the spirit of technology during the First World War, whereas "the ancients' intercourse with the cosmos had been different: the ecstatic trance". The modern man's lust for power, and misreading of technology, that is, technology as the mastery of nature—just like the "imperialist teach", claims the philosopher—led technology to "betray man, turning the bridal bed into a bloodbath". The revolutionary

character of modern technology, and the cosmic experience, was only attained by the destructive powers of modern warfare. Here, the emancipatory potential of technology thus turned into its very opposite. The important proposition to be grasped is that technology does not mean the mastery of nature but the mastery of the relation between the man and nature. Benjamin continues: "Men as a species completed their development thousands of years ago; but mankind as a species is just beginning his". "In technology, a physis, is being organized". Therefore, technology cannot be regarded as an instrumental medium, but rather a way to reach the cosmic experience, as it renders possible the relation between individuals and nature. Nevertheless, only communally can humans ecstatically connect with the cosmos, and the organisation of this collective body requires both nature and technology. As technology, a pure mediation between mankind and cosmos, plays the role of a connector, the Planetarium (the theatre of projection) is the allegorical figure for this global constellation. Hence modern technology is the way to the Planetarium, which will bring a productive, harmonious interplay between humans and nature. This short essay bears Benjamin's political considerations at the outset of the 1930s. Technology can be seen here as a fetish of doom when regarded as a means of domination, but particularly as a key to happiness when it connects with nature on a global scale through a connection mediated with technological communication tools.

Within this scenario, a CyberPark can be seen as the mechanism through which the collective (humankind) can begin to take its own technological potential to foster the joyful connection between humans and nature. The German philosopher wisely identifies the biased reception of technology in the twentieth century: technology produces not only new objects but also new relations and new subjects. Therefore, instead of generating wars, Benjamin claims that politics should concentrate exclusively on bringing forth the organisation of a happy human community, where ultimately technology must subserve the constitution of this global park. This does not mean any cybernetically enhanced humanity, but rather a means to human self-overcoming.

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AUTHOR CONTRIBUTIONS

This project was conceptualised by MK. Resources on the cognitive neuroscience perspective of CyberParks were collected and analysed by MK. The Benjamin's perspective of CyberParks was conceptualised and analysed by CP. The manuscript was written by MK and CP.

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Evaluating Smart City Learning

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Abstract – *Measurement and analysis of individually interpreted learning experiences can build a knowledge picture of how learners perceive immersive technology-mediated learning in smart cities. Comparison of these learning experiences, with theoretical factors derived from relevant literature, may then shed light on the usefulness of theory in practical learning design and approaches to the evaluation of immersive learning environments analysed from a theoretical basis. In turn, this may contribute to current approaches of urban smart city environment planning for citizen engaged 'human smart cities' [14].*

Mobile learning location-based prototypes will be developed with subject experts and implemented in open (urban) spaces located at Upper Barrakka Gardens, Valletta for history and Argotti Gardens, Floriana for botany. This paper discusses potential methodologies for designing a measurement of the effectiveness of these learning experiences and associated learning design for immersive urban learning environments mediated by mobile and networked technologies.

Acknowledging the hybrid nature [9] of smart city learning, interactions between digital tools, content and community, measuring both intra- and inter-learner experiences is anticipated. Identifying and quantifying these dimensions of interactions will help us understand more about how urban smart learning activities create immersive experiences for each learner, engaging them in a variety of internal cognitive and social processes. To clarify mutual interaction between theoretical and empirical factors, a system of theoretical factors of significance is proposed to be developed, and then correlated, with learning experience analysis factors.

A brief review of hybrid learning environment research, including ubiquitous learning [4] manifested in hybrid [9], mobile [8] and smart city [2] environments, provides context for how analytical methodology might be applied to an interactive learning system in smart cities. Phenomenographic techniques of variation and outcome space are investigated, together with the Dialogic Space concept [30] of conversation interaction for analysing dialogues.

Keywords—smart city learning; mobile learning; networked learning; interactions; evaluation system; connectivism; dialogism; community, social media

I. INTRODUCTION

An evaluation system is being proposed to measure effective learning, considering the learner, the underlying design and the authentic immersive environment [24], using pedagogical theory as a basis for measurement approaches. The design of the evaluation

system must be versatile in order to measure and analyse the proposed learning experiences, and then to make measurable connections with theoretical factors derived from an analysis of relevant theory and research discourse.

A. The context of the learning design

The context of the learning design is defined here as incorporating the pedagogical approach taken in the (explicit or implicit) design, the affordance of digital tool(s), the interface design in relation to the learning design [1], the 'target audiences' of the learning design, and the authentic space in which the learning is designed for promoting participation ([8], [27], [7], [4]).

B. The context of the authentic environment

The context of the authentic environment is defined here as learning experiences located in geo-responsive physical environments that mediate interactions between persons, technology and the ubiquitous learning [4] space around them. These experiences may involve synchronous and asynchronous individual interactions with content and a community of learners in the network of participants of the learning experience [28], with digital tools mediating those experiences and facilitating the storage of constructed knowledge in the system ([29], [5]).

C. Mobile learning, WAY-Cyberparks and Smart Data

Mobile learning (ML) prototypes will be developed with subject experts and implemented in open (urban) spaces. At the Upper Barrakka Gardens, Valletta the ML activity is about an identified historical event and in the Argotti Gardens, Floriana about the history and architecture of the place and the potential learning experiences in botany that can be developed at this site. Plans for using similar mobile learning location-based prototypes for other information rich spaces related to different curricular areas such as visual and performing arts will be developed and evaluated as the project progresses. These mobile learning experiences will be mediated by the Way-Cyberparks application (an EU COST funded project research initiative). "CyberParks' main objective is to create a research platform on the relationship between Information and Communication Technologies (ICT) and the production of public open spaces, and their relevance to sustainable urban development. The impact of this relationship will be explored from social, ecological and urban design perspectives." [30]. Augmented reality (mobile) learning may form a potentially significant part of this research.

Smart data is gathered by the WAY-Cyberparks application, in that users running the mobile application on their phones (and actively logged in) can walk through a public space and interact with it through the application. The mobile app persistently collects data about their 'itinerary' that provides researchers with information to develop knowledge on the interactions between users and that space over time. This data can then be used to enhance user experiences when visiting public spaces. This means that over time, a hybrid

immersive technology mediated learning experience can utilise what the community of learners has constructed as knowledge to enhance the overall personal experience for each learner. The term *'smart city learning'* for clarification of interpretation may generally refer to the use of these types of large evolving data sets that can be used to inform design, content or interaction, sometimes instantaneously.

II. LITERATURE

A. The Smart Learning City

Buchem & Pérez-Sanagustín [7] offer useful definitions of smart city learning, '... as "open libraries" containing a huge number of resources, such as buildings or artworks, that can be used for learning...' [14], and '... encompasses formal, informal and mixed learning experiences in urban spaces [...] with embedded technologies, supporting new kinds of learning, especially constructing contextual knowledge by moving and operating in an authentic environment'. The authentic environment that learners inhabit impacts on their perceptions of a learning experience, as 'the location from which the individual participant accesses (the) online environment is an integral element in the participant's learning experience' [16]. This has the potential of 'transforming learners into active citizens' [2], in a 'participatory urbanism' [7] of smart city living. Buchem & Pérez-Sanagustín provide some inspiration for measuring the impact of an authentic environment on a smart city learning experience with their discussion of blended spaces in the 'movements of everyday life', moving between localness and virtuality, allowing learners to play active roles using digital tools of choice and compiling their own learning experiences ([8], [4]).

B. The Interactive System

The interactive system manifested in smart city learning can be considered as a context that provides *interactions* with subject *content* in a particular area of knowledge, through a *digital environment or tool* and involving interpersonal interaction within a *community*. In this context, evaluation of learning experiences is fundamentally about interactions mediated by technology between learners, content and other learners in a networked community. These interactions create a 'seamless' [27] and 'glocal' (Certeau, 1988 in [7], [24]) learning experience that is enriched by augmented reality [7] through which learner citizens progress in their awareness, knowledge and competence development. Also described as 'geo-learning' [27], smart city learning experiences are (predominantly) accessed via smartphones that use location-based technology. These technologies mediate new ways of learning, but also pose challenges. Questions around privacy [13], user accessibility [26] and technology device provision are apparent. Though smartphone ownership continues to increase, especially in Europe [11], participation may still remain problematic. Historically, participation rates have been low for technology mediated learning experiences [18], and the Internet culture 'Rule of 1%' appears to often still be true [9]. While use of social media technologies may facilitate easier access [17], participation and engagement of learners may not increase or improve quality of learning [15]

without active moderation [9] and social presence of facilitators [19]. Learning design, therefore, might need to address these shortcomings.

C. Measuring Interactions

Methods of data capture and analysis in evaluating smart city learning are complex, as the interactions themselves are multi-modal (face-to-face, virtual, networked) as well as multi-voiced, indicating a move 'toward more dynamic, social alternatives that recognise the situated and intersubjective nature of meaning-making', ([12] in [3]). Literature provides useful contexts and inspiration, with particular importance given to phenomenography [22] and phenomenography based approaches [33], networked learning research [6] and dialogism for concepts around dialogic space ([32], [31]), and the *self* identities of individual learners ([32], [3]). Mamaghani et al.'s [21] analysis of children's drawn images outlines an approach to iterative content analysis using phenomenographic variation and outcome space categories which could be applied to smart city learner-generated content experiences iteratively over time or activities. Edwards [10] study of experiences of web-based information retrieval, illustrates an approach to creating phenomenographic outcome spaces relevant to this project, demonstrating multiple layers of experience of the same event, dependent on perspective, prior knowledge and purpose.

Considering interactions with the community, aside from dialogic space and the multi-voiced self and 'other', Pask's [23] notion of 'the limits of togetherness' might inform some of the analysis of comments amongst groups. This may help to establish and measure conversation (defined by Pask as 'concept-sharing') between members of the learning community, as opposed to 'communication which looks like conversation but is not at all conversational [...]', [23]. This may be distinct from whether or not knowledge is constructed by the networked community [29], and Ravenscroft's work [25], with the Interloc application, might offer an alternate way of facilitating knowledge construction, if this is considered a desired outcome of 'effectiveness' for smart city learning. Laurillard's [20] warnings about conversation of learners in relation to learning content and navigation of the digital tool (p111-112), and not in relation to learning content itself, may indicate another layer to measure, as "the material [learners] found was highly relevant [...] yet appears to have afforded no productive response of any kind".

III. DEVELOPING THE FRAMEWORK

A. CyberParks Learning at Argotti Gardens, Floriana & Upper Barrakka Gardens, Valletta

Mobile learning located at Argotti Gardens in Floriana will consist of various mobile learning activities (Points of Interest) linked to 'hotpoints' within and in the vicinity of the gardens. Similar procedure will be applied at the Upper Barrakka Gardens including several Points of Interest for the piloting phase through a single hotpoint. Activated by GNSS (Global Navigation Satellite System) via the CyberParks Android mobile application, a user is offered a selection of PoI, which provide predetermined learning content and functionality to

contribute with user-learner generated content and commentary. The learning design will offer four learning pathways with associated activities: 'History' (the history of the location), 'Structures' (important structures in the location), 'Processes' (industry, manufacturing or social behaviour and traditions at the location) and finally 'Reflect' (follow-up activities and additional learning opportunities) on completing the hotpoint(s) journey. These pathways provide learning for novice level acquisition of facts and concepts, participatory support and guidance level (for additional problem solving), 'metacognition', and for contributory learning. Evaluation of learning therefore is required to establish the process of learning throughout the experience, for 'what' and 'where' domain content is being learned or engaged with, and then also 'how' it is being learned and to what level. 'Who' and 'why' factors also contribute to both domain content processing, as well as additional emotional processing of knowledge and engagement. Learning might be evidenced through the creation of user-learner content or in conversations taking place externally from the CyberParks application, for example using Facebook or Instagram, as well as internally within the CyberParks mobile app.

Technical and learner analytics data, such as the number of connections between learners, frequency of shared content and sentiment of comments will be measured against the stage of learning and learning pathway. Analytics will be available within the CyberParks app and externally using social network analysis techniques. Knowledge construction, concept sharing and dialogue concept expansion in learning experience pathways can be measured using learning outcome criteria developed in conjunction with learning designers, to recognise and record evidence of learning, at which cognitive level, learning stage and pathway. Pérez-Sanagustín et al [24] describe multi-channel, multi-context, multiple-objective 'glue' services for smart city learning. By measuring interactions in relation to geo cached learning hotpoints in AR learning locations, more might be learned about how 'place and space' affect and impact learning quality and engagement in relation to conceptualising the glue that Pérez-Sanagustín's paper discusses. Noting how learner networks form, and the (multiple) roles that learners may adopt, and evaluating the knowledge being constructed 'in the system' it is potentially possible to evidence how 'connectivist' learning in a smart city hybrid technology mediated environment takes place. This may help to develop useful relationships between learning design and learning experience practice and other stakeholders involved in smart city design and planning, such as technical infrastructure specialists, architects and urban community planners.

B. Anticipated learning experiences at Argotti Gardens and Upper Barrakka Gardens

This paper focuses on user-learner interactions and on the prediction and gathering of data for evaluation of smart city learning, specifically from user-learner sample groups, though other stakeholder sample groups are also involved in smart city learning implementations (such as learning designers, content creators, subject area specialists and technical application designers and developers). Focusing on mobile learning location-based prototypes being developed and implemented in open/urban spaces located at Upper Barrakka Gardens,

Valletta for history and Argotti Gardens, Floriana for botany, learning experiences anticipated will include playful learning, citizen enquiry, seamless learning, geo-learning and crowd learning. The structure of data gathering and analysis would be iterative (over time) and in addition be used to investigate a direct or indirect relationship to relevant pedagogical theory and discourse, with a special focus on Connectivism.

C. Evaluating learning in an interactive system - interactions with Content, Digital Tools and Community

In the context of phenomenographical category layers and iteration, and using a dialogic space concept analysis, factors relevant to measuring effectiveness of smart city learning may be derived from data to discover what might be of significance to user-learners. Assessing this learning effectiveness from a variety of user-learner perspectives and analysing relationships with appropriate pedagogy might be then attempted. A first concept of practical techniques using phenomenography is presented here, with ideas for measurement of dialogic space, concept sharing, multi-voiced self and knowledge construction.

The proposed system for evaluation of smart city learning at Upper Barrakka and Argotti Gardens is intended to evaluate experiences for user-learners in relation to principle category interaction variables, in a context of theoretical factors of significance derived from appropriate literature. These category variables - content, digital tools and community – are distinct in their differences, though all are interactions. Consequently, the principle category analysis system needs sufficient commonality for correlation of interactions so as to establish meaningful relationships between them. The system proposed here is an iterative approach to gathering sets of data for each principle category that bears relation and connection to each other.

It is anticipated that there will be layers of analysis for these interaction categories, both for factors of interest and for measurement factors, in order to accommodate all layers of interaction. Principal factors of interest would include factors determining learning, Human Computer Interaction, the impact of the authentic space on the augmented reality learning experience and community and social network presence and activity. *Facts determining learning* would evaluate evidence of facts, concepts, problem solving, meta-cognition in interaction behaviour, dialogue and content. The *impact of the authentic space* evaluates evidence of immersive smart urban space experiences (diverse agents for providing, collecting, creating and sharing information), measurement of seamless learning (blending learning with everyday life) and of 'glocality' (where local and global co-exist). *Community and social network presence and activity* evaluate the sharing, identity building, community role and collective memory building in any learning communities which may form around the experiences. Interface design, functionality affordance, perceived usefulness, perceived ease of use and frictionless journeys (user friendly journeys and navigational design) would attempt to be evaluated as *Human Computer Interaction* factors. Layers of analysis also need to take into account multiple literacy modalities to evaluate these factors of interest for the impact of *types* of content on learners*:* multimedia content (audio, video,

text, images), domain prescribed content, learner-generated content, and comment interaction content.

By utilising ideas drawn from prior research and discourse, the system proposes to analyse these factors. The following examples provided here draw from Mamaghani et al [21] for content analysis features, Pask's concept-sharing [23] and Wegerif's Dialogic Space (of addressee, superadressee, infinite other) [31] evaluation for conceptual presence and relevance to establish depth and scope of factors determining learning, for example novice (acquisition), participatory and contributory [4]. 'Multi-voiced self' concepts [3] could evaluate identity variation and role in the network and community. These measurement factors could be applied iteratively into variation categories for evaluating the content, comments and direction of interactions within the principal category variables.

D. Examples of Interaction Analysis

The following examples of interaction analysis outlined here, including all Tables illustrating some potential variation categories and outcome spaces, are developed by the author as the basis of a proposed system of smart city learning evaluation (with other work cited where relevant). These examples demonstrate how a system of *Interaction Category Variables Analysis* can be used to analyse smart city learning interactions for key factors of interest. Examples given here are firstly for *learner-generated content analysis:* the increase or decrease over learning activity progression demonstrating conceptual assimilation and processing (e.g. [21]) and secondly for *community interactions:* the increase or decrease over learning activity progression demonstrating identity (perhaps with alternate 'self voices', [3], confidence, dialogic space expansion [31] and 'concept-sharing' [23]. A third example of *digital tools interactions* is provided, to measure growing technical efficacy and engagement with digital tool affordances, which could be evaluated for surface and deep interaction functionality efficacy and network participation throughout the learning experience. Looking at *social channel engagement* can further investigate processes of knowledge construction, concept sharing and roles, and consequent evaluation of the significance of social network interactions and functionality at stages of learning and as a whole. Attempting to evaluate a*uthentic environment relevance and engagement in content detail* through evaluating the increase or decrease over learning activity progression, which may be evidenced in comment interactions, sharing and learner-generated content.

1) Example 1 – Interaction with learner-generated content

Example 1 (Table I) looks at how learner-generated content interactions may be analysed, either within the CyberParks app or externally in social channels such as Facebook, Twitter or Instagram. Content analysis follows a concept of phenomenographic context in iterative learning stages.

An example of learner-generated content analysis: A study on analysis of children's drawn images with themes of waste recycling [21] outlines an approach to iterative content analysis using phenomenography variation and outcome space categories. This approach

of multi-stage analysis lends itself to the analysis of learner-generated content in smart city learning, as learning experiences may have stages of learning or multiple tasks or activities which progress the learners understanding of the concepts being discussed. If tasks were designed to request learners to upload content at intervals related to specific activity stages, attempts might be made to understand and measure their levels of cognitive processing, engagement, social learning and dialogic space interaction.

Example 1 may include more granular variation categories for emotion of content and relevance of content to topic, and go on to be developed for analysis of content at stages of learning activity.

2) Example 2 – Interaction with the community

Example 2 (Table II) looks at how community comment interactions may be analysed, either within the CyberParks app or externally in social channels such as Facebook, Twitter or Instagram. Comment analysis follows a concept of dialogic space in a phenomenographic context.

An example of dialogic space analysis: If interactions in the community were grouped into types of statements, association could be recognised and grouped with addressee (direct), superaddressee (the 'third perspective'), and infinite other (infinite perspectives appearing from those previously referenced by self or group). These could then be counted and analysed iteratively to establish when and where expansion of dialogic space was being evidenced in relation to learning task, activity or stage in pathway.

Wegerif & Ferreira [31] indicate a system of dialogic space that could be developed and implemented, with "Students unpack(ing) opportunities collaboratively looking for attributes and relationships among concepts and new ideas, [...] to organize the information". Categories can then trace the development of the dialogic space for evidence of expansion and reflection.

Example 2 would also include *practical* 'when and where' variation categories to evaluate stages of learning in relation to the authentic environment. Affective (emotion) categories here are more defined than Example 1 as it may be expected to be more evident in relation to learning experience perceptions.

Example 3 – Interaction with a digital tool

Example 3 (Table III) looks at how user-learner interactions may be analysed for the technology mediation of learning

interactions, predominantly within the CyberParks app though also externally in social channels such as Facebook, Twitter or Instagram. User-learner behaviour analysis follows a concept of usability techniques, and also phenomenographic context in relation to learning experience interactions.

An example of digital tool interaction analysis: This involves looking at a number of factors, both those integral to learning interaction affordance and those of human computer

interaction and interaction (interface) design. With a mixed approach to analysis using pedagogical factors and usability heuristics some understanding might be derived as to the role of technology mediation and affordance in relation to learning experiences at surface and deep level.

TABLE I. EXAMPLE 1 - INTERACTION WITH LEARNING CONTENT, PREDICTED OUTCOME SPACES

OUTCOME SPACES (PREDICTED) **EXTERNAL REFLECTOR:** *UPLOAD PHOTOGRAPH TO LEARNING ACTIVITY*		**THEORY/ PEDAGOGY SPECIFIC FACTORS**	**THEORY/ PEDAGOGY GENERAL FACTORS**
Variation Category 1: When it was taken	I took it before I started (the activity) I took it during the activity but before I finished I took it after I finished the whole thing I took it on task number or task name Time of day	Authentic environment, relevance Knowledge construction Engagement	***Issues/factors to consider:*** Participation, confidence in sharing, technical efficacy ***Theoretical discourse that might be found and matched:*** Student as producer Student centered Participatory based activities Mobile 'web 2.0' pedagogies (creative, self-directed)
Variation Category 2: Where it was taken	The location in general The location, at the learning 'stage' or activity area Somewhere else related Somewhere else not related	Authentic environment, relevance Knowledge construction	
Variation Category 3: What is in image and relevance	Building, Tree, Flower, Art, Person, Statue, Animal Type of shot: Vista, Close up, detail On or off topic	Authentic environment, relevance Knowledge construction	
Variation Category 4: Who is in the image	Friends Family Strangers Classmates Myself No one	Identity, community identity, multivoiced identities, role, self efficacy	
Variation Category 5: Emotion of content	Violent Angry Peaceful Happy Beautiful	Emotion of engagement Group identity Self efficacy Role	
Variation Category 6: Why it was taken	I felt like it I wanted to show I was there My friend looked cool I was into it I wanted to remember My mum asked me to It looked really old It was pretty	(Positive and negative) Engagement Learning authenticity Creative approach	

TABLE II. EXAMPLE 2 - INTERACTION IN THE COMMUNITY (COMMENTS), PREDICTED OUTCOME SPACES

OUTCOME SPACES (PREDICTED) **EXTERNAL REFLECTOR:** *INDIVIDUAL* *POSTS COMMENT (E.G. ABOUT IMAGE)*		**THEORY/ PEDAGOGY SPECIFIC FACTORS**	**THEORY/ PEDAGOGY GENERAL FACTORS**
Variation Category 1: Who is being addressed (or referenced)	Named Individual Inferred individual The specific group on that thread A generality of assumption Summoning larger perspective	Identity Role Dialogic Space Knowledge construction	***Issues/factors to consider:*** Community, communication confidence, identity, self and other efficacy awareness, critical thinking and awareness, willingness to share knowledge, risk, ***Theoretical discourse that might be found and matched:*** Dialogic space Addressee Superaddressee Infinite Other Multiple identities (p-individuals, multi-voiced selves) Community and communication Concept-sharing Personal Learning Networks Collaborative Learning Communities of Practice Social presence of experts
Variation Category 2: (comment content)	Concrete concepts Questioned knowledge Trivia Opinions Shared facts	Roles Experts Self efficacy Knowledge construction Concept sharing	
Variation Category 3: Active contributions or questions to discussion	What if we... What are you saying about ... What makes you say that? If such and such was the case ... In class we did ... I remember another similar ...	Dialogic space Concept sharing Multi-voiced self P-individual	
Variation Category 4: Tone/emotion positive or constructive	That's so true Hahahaha It's amazing Gorgeous/lovely idea/work/skill Imagine if ...	Emotion of engagement (sentiment) Empathy Conceptual assimilation Knowledge construction Concept sharing Authentic learning Confidence and sociability Purpose /understanding	
Variation Category 5: Tone/emotion negative or destructive	That's rubbish I don't believe that You just made that up Negative memes		
Variation Category 6: Tone/emotion neutral	I have no clue what you're talking about No idea Off topic		

TABLE III. EXAMPLE 3 - INTERACTION WITH DIGITAL TOOL PREDICTED OUTCOME SPACES

OUTCOME SPACES (PREDICTED) **EXTERNAL REFLECTOR:** *REGISTER ON THE WAY-CYBERPARKS APPLICATION*		**THEORY/ PEDAGOGY SPECIFIC**	**THEORY/ PEDAGOGY GENERAL**
Variation Category 1: Negative Registration experiences	I hate doing this kind of thing It was too fussy I couldn't use Facebook I don't use social media anyway It didn't work I don't give my email to anyone *Other negatives*	Sociability Self efficacy Digital literacy Perceived usefulness Perceived ease of use Privacy Confidence	***Issues/factors to consider:*** personal identity, privacy, confidence, trust, sociability, consent, purpose, engagement ***Theoretical discourse that might be found and matched:*** Identity, trust, perceived usefulness, curiosity, discovery, sociability online
Variation Category 2: Positive Registration experiences	It was ok I had no problem Mum said it was easy I think its fun I used a mad username I thought I might use it again so it was worth the hassle *Other positives*	Sociability Self efficacy Digital literacy Perceived usefulness Perceived ease of use Privacy Confidence Curiosity	
Variation Category 3: Neutral Registration experiences	Not sure Don't know Didn't think about it *shrugs shoulders* Mum did it *Other neutrals*	Sociability Self efficacy Digital literacy Perceived usefulness Perceived ease of use Privacy Confidence	

Example 3 might be developed to include other categories for technical self-efficacy (surface and deep structure of the tool for information design and pedagogical features) and emotions about technology. Surface structure interactions refer to interface functional activity, navigation of content and system understanding or technical manipulation of content (creating, editing or sharing content). Deep structure technical interactions may be a measurement of how many interactions a learner makes with asynchronous community members, or connects and interacts with an external expert about domain content or query problem solving.

IV. PARTICIPANT SECOND ANALYSIS

A type of analysis conceptualised by the author, known here as 'Participant Second Analysis' might be utilised, where it may be possible to see how participants themselves analyse and interpret interactions. Discussions and category analysis using card-sorting techniques

might be particularly enlightening for learner-generated content interactions and community interactions, and could be carried out after a learning activity or during the event. This would elicit think-aloud or focus group data, from participant groups or with individuals.

I) Participant Second Analysis for learner-generated content

(Table IV.) Potential questions for learner-generated content, looking at content shared in social media channels or in the WAY-Cyberparks app, individuals or groups could be asked to talk about the content.

TABLE IV. EXAMINING LEARNER-GENERATED CONTENT INTERACTIONS IN PARTICIPANT SECOND ANALYSIS

POTENTIAL QUESTIONS ABOUT PHOTOGRAPH OR VIDEO CONTENT GENERATED BY THE LEARNER (LEARNER-GENERATED CONTENT)	**THEORY/ PEDAGOGY SPECIFIC FACTORS**	**THEORY/ PEDAGOGY GENERAL FACTORS**
Where was it taken? Describe to me in your own words Location and stage in learning activity (factual) What does it represent? Is this image important to you? In what ways? What is in the photo? – Describe the scene in your own words: (A building, view, landscape, close up detail, atmosphere) – Do you like it? If so, what made you like it? If not, why not? People you know – who are they? Is it important they are included? Why? People you don't know – why did you take it with them in it? Yourself – why did you take a selfie? What does it represent or mean to you? Why was it taken, what inspired the action? Did you share it? Where, with whom? Why did you share it?	Knowledge construction Authentic environment situated learning Meaning making Concept-sharing Concept assimilation Multiple intelligences	Student directed learning Student participation Creative pedagogy Personal learning Learner agency and autonomy

These questions and similar ones in semi-scripted interview or focus group discussion can expand a dialogic space for the learner(s) to tell us about what they experience in a learner-generated content interaction. We are then able to deduce more about levels of concept construction and assimilation, identity development and critical analysis skills.

2) Participant Second Analysis for community interactions

(Table V.) Potential questions about comments made by learners in networked community scenarios, looking at comment threads made in social media channels or in the WAY-Cyberparks app, individuals or groups could be asked to talk about what was going on in the thread. These and similar probing questions could shed light on how learners feel when interacting in comment threads, how they might be developing conceptual understanding, how the process promotes or hinders this, expands and develops dialogic space and can perhaps be measured to create variation categories using some criteria discussed in [31].

TABLE V. EXAMINING INTERACTIONS IN THE COMMUNITY (COMMENTS), IN PARTICIPANT SECOND ANALYSIS

POTENTIAL QUESTIONS ABOUT COMMENTS MADE BY LEARNERS IN NETWORKED COMMUNITY SCENARIOS	THEORY/ PEDAGOGY SPECIFIC FACTORS	THEORY/ PEDAGOGY GENERAL FACTORS
Who are you talking to there? Why did you say that at that point? Did you mean you agree with that statement, or disagree? Did you get the feeling people liked you in the group? Did you get the feeling people disliked you in the group? Did you feel that comment was bossy or aggressive? Did you want to say more there, and held back? Did you think that some of the people chatting were very knowledgeable? Did you feel shy? Why? Did you feel like it was fun or interesting? Why? Did you think this was a boring thread? Did anyone talk about (insertfactual or relevant info on topic)? Was anyone trolling or being annoying? Why did you start posting in the thread?	Multi-voiced self Identity making Roles in community and network (novice/expert) Confidence Self efficacy Meaning making Concept sharing Dialogic space expansion	Student directed learning Student participation Creative pedagogy Personal learning Learner agency and autonomy

V. CONCLUSIONS

Measuring the effectiveness of learning without resorting to assessment is a challenge in any conventional classroom. To attempt this, with additional challenges and variables posed by physical space and technology mediation impact, further complicates the analysis methodology. However, by looking at the interactions first, for authentic space context, community concept sharing and human computer interaction factors, insight can be gained.

Through diligent analysis of the findings, a contribution can potentially be made to urban planning as well as for technical application and learning design. A question persists: is interactivity engagement a reliable measure of learning effectiveness? The rate of active learner participation may not reflect levels of engagement or cognitive processing [15]. Data gathered from interactive geo learning experiences located in Valletta may yield findings to shed further light and contribute to greater understanding in this particular discourse if this question is acknowledged.

Overall, creating effective learning design pedagogy for smart city learning, with its multiple strand stakeholders, considerations and analytical layers, is an evolving process to be established by ongoing research, discourse and interpretation. Many ethical considerations - not discussed in this paper - are potentially problematic for smart city learning, for data privacy, data anonymity, intellectual property rights, legal aspects of terms of use, accessibility and digital literacy amongst others. By gaining insight into levels of usefulness, engagement and learning quality, these separate challenges might have a wider knowledge base on which to form new approaches in some of these areas.

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Public Spaces as Evolving Frameworks: Applying Principles of Co-creation in Urban Planning

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Abstract – *There is a growing body of literature that recognises the advantages of collective human actions in various contexts. People can have more insights and social experiences when they collaborate in groups and can achieve better results than any single individual. In this paper, we argue that co-creation can be used in urban planning by treating citizens as active, creative, decision-making equals rather than passive recipients of top-down design. Rather than asking for citizen commentary on already set initiatives, collaborative techniques view city populations as agents of positive change, giving communities tools of direct involvement in outlining their needs and priorities, collaboratively finding solutions, influencing decisions and achieving better outcomes. The focus of this article is the creation of a typology of citizen engagement strategies in urban planning, which sheds light on broader issues around the relationship between technology, urban development and public participation. By exploring and critically assessing case studies of citizen co-creation in the city context, we attempt to show how citizen engagement can lead to construction and redefinition of public spaces.*

Keywords— co-creation; urban spaces; citizen engagement; smart cities.

I. INTRODUCTION

"Urban spaces and places are publicly-owned areas such as streets, parks, bike paths, streetscapes, recreation areas, green spaces and public squares. They are key components that enhance quality of life and well-being in cities. Public spaces are the 'hubs' around which communities organize. Both historically and currently, public spaces provide a sense of community, identity, belonging and inclusion, which can improve physical and mental health, spiritual and cultural well-being, and creative expression" [1]. Due to exponential development and growth of urban areas worldwide, public spaces are becoming increasingly important.

There is a growing body of literature that recognises the advantages of collective human actions in various contexts ([2], [3], [4]). People can have more insights and social experiences when they collaborate in groups and can achieve better results than any single individual. Involvement of citizens in planning processes is especially important topic in the research stream of smart cities ([5], [6], [7], [8]). While reviewing the literature about smart cities, it is obvious that research on tools for thought and decision-making is very limited compared to deliberations on infrastructure management (e.g. IoT integration, transport management).

In this paper, we argue that co-creation can be used in urban planning by treating citizens as active, creative, decision-making equals rather than passive recipients of top-down design. Rather than asking for citizen commentary on already set initiatives, collaborative techniques view city population as agents of positive change, giving communities tools of direct involvement in outlining their needs and priorities, collaboratively finding solutions, influencing decisions and achieving better outcomes. Contemporary channels of communication and information enable new ways for broader groups of people to collaborate in shorter amounts of time. It also allows officials to develop dynamic dialogues with citizens through shared networks, virtual collaboration tools. This leads to deeper relationships reinforcing development of smart and inclusive society.

Problem: What are the tools and strategies of citizen engagement in planning processes of urban spaces enabling co-creation?

Goal: The creation of a typology of citizen engagement tools and strategies in the development of urban spaces, which could provide insights on broader issues around the relationship between technology, urban development and public participation and provide conceptual ground for further research efforts.

Methods: literature review and synthesis, analysis of case studies.

II. THE ROLE OF CITIZEN ENGAGEMENT IN URBAN PLANNING

The definition of the citizen engagement concept is complex. It has been referred and illustrated with myriad explanations and meanings throughout the literature. In general, public participation is widely viewed as a basic condition of decision-making at all levels of governance (i.e. EU level, national level, community level, city level). More complex definitions have several building blocks in common: voluntary participation, citizen actions (e.g. volunteering, voting, donations) and it always refers to engagement in something. Thus, it makes no sense to discuss citizen engagement outside of a specific context. This article in particular focuses on citizen engagement in the context of smart and evolving cities.

There is an extensive discussion on appropriate forms and magnitude of citizen involvement in decision-making [9]. Traditionally, citizen participation focused more on forms of indirect involvement (i.e. voting). Recent societal and technological developments drive the need for broader and more direct forms of citizen participation. Opportunities for dialogue, deliberation, and creativity are transforming the culture of participation [10]. Innovative approaches towards citizen engagement (e.g. application of design thinking approaches in face-to-face collaboration with citizen, experiments with online democracy tools and platforms) are applied rapidly in local, national and even international (e.g. United Nations, European Union, World Bank) entities. De Lange and De Waal conclude that use of new media, technologies and collaborative methods promise several qualitative shifts in the way the public is engaged and empowered [5]: (1) collective issues can be defined and made visible more efficiently (e.g. use of big and open data); (2) engagement using

collaborative technologies and social media allow citizens to feel as a part of something bigger; (3) media technologies empower self-organisation when solving collective issues; and (4) media technologies allow individuals to act in new ways (e.g. design certain features of their cities or collectively govern urban issues).

"While participation in planning has been the subject of much theoretical debate in academic circles, there has been disproportionally little practical experimentation and development of new approaches involving the lay public in the planning process. The means for participation in planning that are usually provided are based more on consultation (hearing) rather than participation (listening)." The traditional process of urban planning is illustrated in Figure 1 below. According to Mart, such models are more rational tools and implies technical hierarchy which often means that the involvement of the public depends solely on elites' will and the help of experts [11]. In addition, citizens influence only a few aspects of planning process (highligtted in the Figure 1).

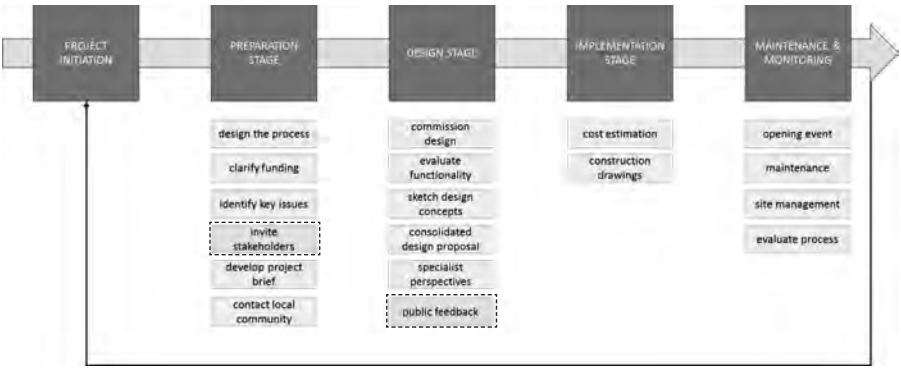

Fig 1. Traditional process of urban planning (developed by authors, 2016).

In current settings (i.e. globalisation, spread of ICT use, etc.) citizen engagement in urban space planning should, in our opinion, be approached holistically. Co-creation offers an interesting perspective in this respect, as it enables the integration of a range of ICT-mediated and offline participatory methods and processes. Co-creation is a new approach to development of urban spaces moving from domain of urban planners to a shared domain between professionals and citizens. Co-creation entails: connections (interactions between people, such as companies and customers, not just interactions between consumers and products) and collaboration (rather than just involvement). In its optimal form, co-creation has the dual benefit of reducing public sector costs and increasing stakeholder satisfaction [12].

Traditional models of citizen engagement into urban space planning can be considered outdated for several reasons. First, due to increased abilities of citizens to collaborate (e.g. new technologies, tools), many of the planning stages overlap and may be undertaken

in a different order. A more appropriate model of engaging citizens would look more like cyclical management of planning and not a linear sequence of activities. Second, there are many methods of citizen engagement that could be used at multiple stages of the planning process [13]. Third, mapping methods in a linear manner would not portray real-life situations. Linearity suggests that planning processes always have a definitive beginning and end which is not always true in development of constantly evolving urban spaces [13].

Our proposed model of co-creation in urban planning consist of two layers. The first layer involves the traditional stages of urban planning (which may overlap or be merged). The second layer is based on the management of citizen input which was created by Mindlab laboratory [14]. Mindlab's main focus was social innovation in the public sector, and due to this, it can be applied in urban planning too. The model of the co-creation process in urban planning is pictured below in Figure 2.

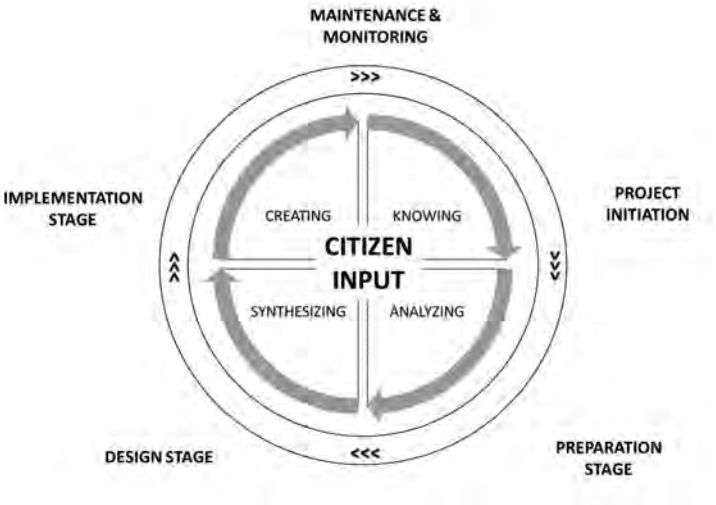

Fig 2. Model of co-creation approach in urban planning (developed by authors, 2016).

Further in our study we will develop a mapping methodology for citizen engagement strategies leading to co-creation in relation to urban planning process based on the analysis of qualitative analysis of selected case studies.

III. MAPPING THE METHODS OF CO-CREATION IN URBAN PLANNING: TOWARDS A CONCEPTUAL FRAMEWORK

The following section will analyse case studies of collaboration between citizens and architects in creation of multifunctional solutions for existing urban spaces in Lithuania (Vilnius and Biržai). The cases were chosen for their diversity and will allow insights into the factors influencing the success of co-creation in urban planning. Case studies were analysed on three levels, i.e. strategy, organisation and processes, in order to develop

critical dimensions for the conceptual model for mapping engagement strategies and could be used as a foundation for further scientific investigations.

A. Case study 1

1) Context & tackled problem

Four groups of architects analysed the territory of three blocks in order to provide visions for an up and coming district. The area in question lies in a former industrial territory. It is now inhabited by strong-bounded and creative communities of artists, musicians and people alike. The cooperative spirit, willingness and ability to achieve solutions of these communities is extremely important factor in the success of the conversion project. A key problem is an extensive use of existing spaces (clear potential to become public spaces)/abandoned inner yards still used for industrial purposes / closed inner yards formerly used as technical areas for industrial purposes (loading, unloading, storages, technical equipment).

2) Strategic role of citizens

Citizens are part of the workshop. However, their input is limited to providing information and evaluation of proposals.

3) Organisation of the work with citizens

The groups of architects used citizens and communities as a source of information. Their input was as important as current building regulations, researches, historic information or opinions of other professionals. Communities living and creating in the district were included and analysed. In addition, alternative solutions such as a union of all communities were proposed too.

4) Processes of citizen input management

Three processes of citizen input management could be distinguished after analysis of the workshop processes.

The Game. Architects and urban designers use their knowledge and research to identify different typologies of existing spaces. Areas are then divided into "top-down" (uninhabited, public) or "bottom up" (inhabited) types. In the context of this workshop, the bottom up type refers to spaces presented to communities as a playground and mapped using a grid. Every member of the community has a spot of ground or rooftop to use according to their own preferences. Areas are then analysed to find an areal pattern of suggestions, as an open data for further solutions. Top-down areas, in the context of this workshop, are then connected with bottom down ones, according to the areal maps, using proposals of the professionals. *The Game* has great potential for data gathering on various issues concerning urban spaces.

The Hobby. The area is analysed as a solid playground (giving the fact that other aspects of life such as accommodation and occupation is already taken care of and not in the field of possible change), place of active/passive recreation. The population of citizens are

divided into communities, giving them freedom to decide what kind of activity they prefer, also suggesting activities for neighboring communities. Each of these suggestions are presented to all the communities, trying to find people with similar interests. This way a community is aware of other communities and also responsible for its well-being. This strategy of co-creation creates a chance for democracy, but also takes care of individuals, that might not agree with the majority, and gives them the possibility of using property of other communities nearby. This solution is, or can be based on community with similar aims or hobbies, as well as group of people with similar professional or recreational interests.

The Open City. The area is analysed as a space, to create an open urban community. Given the fact that there are several existing and active communities of younger inhabitants already in the area, there are residents (especially seniors, living there for a longer time), that are usually more self-involved and not willing to participate in changing the area. The most important aspect, is that given communities operate in their physical boundaries, provided by urban architecture, which no longer functions, and is no longer needed to function. The solution is presented by architects and urban designers, who provide a top down approach to the evolution of the area in question, right until the limit, where they meet bottom up approach. In other words, the professionals provide the necessary solutions to create a space for a community. The community then creates a goal, to unite all individuals. Goals can be continuous, ever changing – like creating a sculpture - or constant - like an open cinema or rooftop football pitch. For this model to work, a model of compensational mechanisms is required. To provide a space for community projects, a lot of private property can be effected (taking down existing low quality buildings, creating pathways on private land, removing parking spaces from territory, etc.). But if these difficulties are solved by professionals, a lot of the bottom up activity could be liberated. The aspect of motivation is greatly important in this model.

B. Case study 2

1) Context & tackled problem

A workshop in a small town of 15,000 citizens. Deserted, disconnected public spaces, parks and recreational areas. Wide, uninhabited areas called as public squares as a result of Soviet city planning, for a city, which has lost half of its population.

2) Strategic role of citizens

Equal citizen and professional involvement in the workshop process.

3) Organisation of the work with citizens

Citizen involvement:

- Since the workshop is organised in a close community, consisting largely of non-professionals, although active and cooperative individuals, several key guidelines have been presented. These so-called guidelines have been previously prepared by professional urban designers, architects, scientists and even politicians in the form of

lectures and discussions. At this point the community already knows the professional opinion, and still can present their own point of view.

- Presentation of ideas comes in the form of "idea bank", which is anonymous, but is still available only to individuals who are participants of these presentations, explained in stage 1. This way the community member has the knowledge, understands the problems and possible solutions, and most importantly, limitations on what can or can't be done.
- Community elects ambassadors – usually the most active and respectful community members - to represent their opinions during the workshop, and to make sure, that the "idea bank" is respected during all the stages of the workshop. Elected ambassadors are divided into groups, to join the teams of professionals, to help them during the entire workshop process.

Professional involvement:

- Teams of workshop participants - professionals are selected according to their professional strengths, working with the communities is one of the key factors to be able to participate in this kind of workshop. A person/team member with this kind of knowledge – usually a sociologist - is considered to be a major advantage. Teams attend the same lectures and presentations to understand the specifics of the area in question and they are given time to evaluate the information.
- Teams of professionals are then united with the ambassadors of the community, they become team members, using the sociologist as a bridge between the professionals and the community.

The further usage of community members during the workshop process is left entirely to the team chemistry.

4) Processes of citizen input management

The case study shows three different paths that the teams took:

- Community is considered to be a client. Ambassadors are involved in the design during the whole process, from the idea generating and brainstorming, to the presentation. Ambassadors and the community become co-authors of the final blueprint. This gives strong motivation. The success, although, relies greatly on characters and individuals from the professional and community sides, whether they are willing to exchange ideas, cooperate, make compromises.
- Community representatives. Ambassadors are considered to be the source of analysis (e.g. SWAT), when they do not participate during the design process, or only maintain a role of protecting and explaining the suggestions of the "idea bank". They are later invited to evaluate final designs inside the group and express their opinion. This way of using the community allows greater influence of professionals, which maintains the top down approach, and helps the final blueprint to be more professional. The motivation in this case is highly questionable, but still has a lot of citizen involvement, especially during the first design stages.

- Community representatives. Ambassadors are paired together with professionals inside the group. These groups-inside the group provide their own concepts of design, which are then evaluated and the best ones are then developed. This model is similar to the first one but is not necessarily the most citizen involving one. The success of this collaboration highly depends on the communication abilities, chemistry between an ambassador and professional. It also creates rivalry and competition inside the group, which effects the motivation of other participants. Although this model has its flaws, it might lead to the best design, since several design ideas are presented inside the group, and the best one is developed.
- Each of these models, explained above, relies greatly on the sociologist – a person providing a dialogue between professionals and citizen representatives. It's a highly educational model, which provides the citizens with a better knowledge of the problems in their area (explained by professionals), and also helps architects and designers to get the feeling of local ways and ideas.

C. Insights from the case studies

The analysis of case studies allows to identify two key dimensions for organisation of engagement strategies leading to co-creation in urban planning into a typology. Both of these dimensions are based on the role of the citizens in the planning process. The first dimension is the level of professional aid that citizens get when participating in urban planning initiatives. It allows us to differentiate the engagement strategies according to the level of control provided to either citizens or specialists (e.g. architects, experts). The dimension is important due to information asymmetry which is apparent in urban planning. Urban planners and architects employ specific, technical knowledge in their work and this limits communication with citizens. In the traditional process of urban planning, this presented citizens with a choice to resist the planning proposal in initial phases or to remain in the process and participate according to the already set rules. The co-creational approach relies greatly on the support that citizens get when collaborating and participating in dialogues with professionals. The second dimension is the type of input provided by citizens. This dimension specifies if the citizens are only providing information necessary to make decisions or are fully involved in collaboration when developing future solutions for public spaces.

We will discuss different types of engagement strategies in more detail to provide guidelines on selecting the methods.

Consultation strategies. This type of engagement strategy focusses on the gathering of citizen feedback on suggested alternatives and solutions. It includes online and offline methods, such as: focus groups, surveys, meetings, e-petitions, advisory committees, visual preference surveys, creativity groups and demonstrations & transformations.

Involvement strategies. Involvement strategies are aimed at direct work with the citizens throughout the process. It ensures that citizen concerns are consistently considered. The methods include prototype testing, usability testing, idea generation with lead-users,

ethnography, emphatic design techniques, citizen experiences mapping, creativity groups, and walkability assessments.

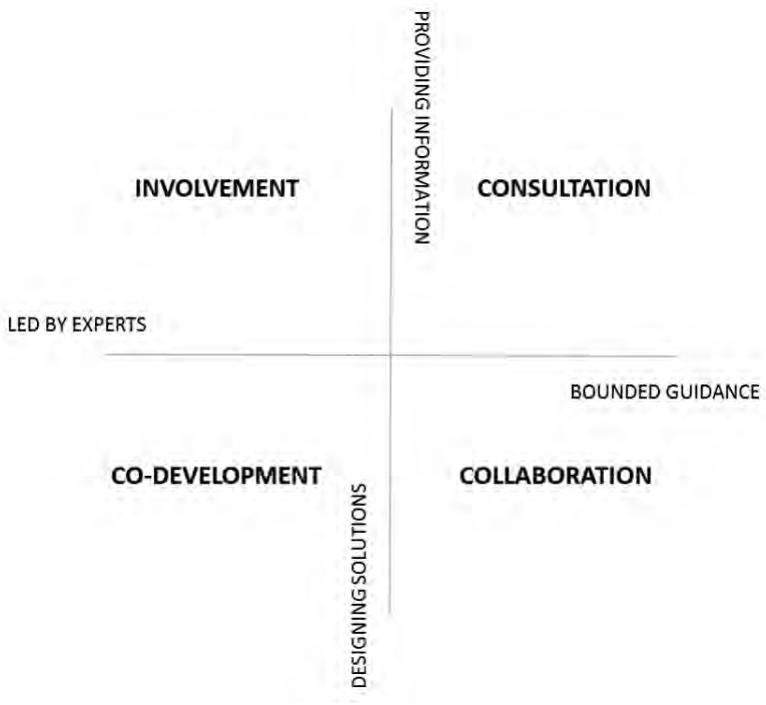

Fig 3. Framework for mapping the methods of citizen engagement strategies leading to co-creation in urban planning (developed by authors, 2016).

Collaboration strategies. The goal of this group of strategies is to partner with citizens and community in all aspects or urban planning. The methods include, but are not limited to, participatory design workshops, online citizen communities, living labs, innovation jams, participatory mapping, and idea banks.

Co-development strategies. The goal of this group of strategies is to partner with citizens and community in all aspects or urban planning. The methods include: wikiplanning, crowdsourcing contests and design thinking workshops.

IV. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Research literature on citizen engagement in the definition, creation and design of urban spaces is rapidly expanding, but it is still chaotic and needs more structure and more defined key concepts. The proposed typology allows analysis of engagement strategies based on two questions: what kind of input citizens are providing into planning process? And what kind of aid are citizens getting from professionals? This model serves us as a framework for mapping available methods of citizen engagement in urban planning. The

typology of engagement strategies could be useful for architects and public planners who seek more in-depth knowledge on innovative methods of involving citizens in urban planning. The proposed typology also can be useful in future research efforts on citizen engagement in urban planning's application of co-creation principles. Further research could be conducted on the motivation of citizens to participate in urban planning process.

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CyberParks and Geoaesthetics

Reading modern technology after Nietzsche

Catarina Patrício

Abstract – *Although Nietzsche never mentioned the term geophilosophy or geoaesthetics, from his work emanates a thought connected to the Earth, and to a new direction for the Earth, in order to achieve the Übermensch. Geoaesthetics is assumed as the latent purpose of Nietzschean geophilosophy, aiming to build the world from the artist's figure. And all can be artists, when thinking and constructing, critically and creatively, one direction to Earth (Sinn der Erde). This construction presupposes a Menschen-Erde, that is, a planetarian humanity – that might be attained communally through new medial practices. Now, with the expansion of territories through technics, construction isn't exclusive to real space, but also concerns virtual or outer space architectures. This is an attempt to read the notion of CyberParks through Nietzschean perspective and regards the implementation of land art and site-specfic art projects as further developments of a CyberPark.*

Keywords—Geophilosophy; Geoaesthetics; CyberParks; Technics; Planetarium

«You're on Earth. There is no cure for that.»
Samuel Beckett, *Endgame*

I. A NEW DIRECTION FOR THE EARTH

Although Friedrich Nietzsche never appointed the expression geophilosophy nor geoaesthetics, from his work emanates a thought connected to the Earth, and to the construction of a new *direction for the Earth* (*Sinn der Erde*), in order to achieve the *Übermensch*, or *overhumanity* – one of his most significant concepts and that sets the question of self-overcoming.

In *Thus Spoke Zarathustra*, Nietzsche conduces an all-encompassing uprising of Geography and Geology against the domination of History, which Hegelians required in order to locate historical events in a temporal organisation of the world. Often described to be Nietzsche's most paradigmatic work, *Thus Spoke Zarathustra* is also considered unusual and hermetic. This has made possible different sorts of reception. This paper is one of them; an attempt to read Nietzschean geophilosophy and geoaesthetics expanded by the question of modern technics. Additionally, I regard the implementation of land art and site-specific art projects as further developments of a CyberPark[1] and as workable territories to set a geophilosophy through geoaesthetics.

Nietzschean *Übermensch* is the creator of new values: it is collective solution for mankind, and without any moral principles. Nothing is imposed to the *Übermensch* but to reconnect

[1] CyberParks: fostering knowledge about the relationship between information and communication technologies and public spaces supported by strategies to improve their use and attractiveness (TU 1306) is a Cost Action (European Cooperation in Science and Technology), a network of investigators under open access. For more visit: http://cyberparks-project.eu/

body and spirit[2] – what Zarathustra allegorically calls the conflict between *plants* and *ghosts* – in a substantial element of global extent, exuded from the Earth. *Thus spoke Zarathustra:*

> But whoever is wisest among you is also just a conflict and a cross between plant and ghost. But do I implore you to become ghosts or plants? Behold, I teach you the overman! The overman is the meaning of the earth. Let your will say: the overman shall be the meaning of the earth! I beseech you, my brothers, remain faithful to the earth and do not believe those who speak to you of extraterrestrial hopes! They are mixers of poisons whether they know it or not. They are despisers of life, dying off and self-poisoned, of whom the earth is weary: so let them fade away! Once the sacrilege against God was the greatest sacrilege, but God died, and then all these desecrators died. Now to desecrate the earth is the most terrible thing, and to esteem the bowels of the unfathomable higher than the meaning of the earth! [1], p.6

It is by freeing himself from the local and mythical binding, that the *Overman* is thus the *meaning* and the *direction of the earth* (*Sinn der Erde*). Zarathustra exhorts to the abandonment of transcendental promises, and even nationalistic motivations[3], to engage a single planetary movement. The proposal is based on a collective, trans-local and decentralised drive based on geology and geography. Or, to be more precise, and in order to be immense and endurable, a reformulated history must presuppose geography, geometrics, geology, geophilosophy and geoaesthetics. Nietzsche's concepts are catalysers of a Geophilosophy.

In our view, the planet Earth becoming central to thought is one of the essential premises for the implementation of CyberParks.

II. GEOPHILOSOPHY

The concept of *Geophilosophy* appears firstly in Gilles Deleuze and Felix Guattari last book together *What is philosophy?* (1991) and steams from Nietzschean philosophical positioning of the Earth, who they regard as the first geophilosopher.

And what is the reception of Gilles Deleuze and Felix Guattari of Nietzsche's geophilosophy? Precisely this essential connection to the Earth:

> Subject and object give a poor approximation of thought. Thinking is neither a line drawn between subject and object nor a revolving of one around the other. Rather, thinking takes place in the relationship of the territory and the earth. [2], p.85

Following Nietzsche, Gilles Deleuze and Félix Guattari read the world and the human mind through the geological paradigm, employed in metaphysics landscape metaphors.

[2] The 'overman' whom Nietzsche proclaims demands an unconditional affirmation of the present: he wants nothing other than itself – which is to say, its own expansion and intensification, and that will entail a reconnection of body and soul – what Nietzsche refers to as *plant* and *ghost*.

[3] Anticipating discourses in geopolitics, or 'The Will to Power' which lead to misconceptions of Nietzschean philosophy, wrongly regarded as proto-Nazi.

For Deleuze and Guattari, philosophy *is* thinking immanence[4]. They claim that '*thinking consists in stretching out a plane of immanence that absorbs the earth'* [2], p.88. So the proposition is to set a new geographic model of philosophical positioning[5], where thinking is not entirely a subjective activity but rather takes place in the relation between territory and the Earth.

Furthermore, by seeking the Earth, Deleuze and Guattari propose the decentralisation of Greek Philosophy[6]. Finally, they object the role Hegel commends to world History, i.e., that of the 'German Fate' in the History of Philosophy, if we are allowed to say so. Despite the 'German dream'[7], claim Deleuze and Guattari reviewing Hegelian ossified German Idealism, there is no universal democratic state[8]. But the point is to know whether this enveloped universal tendency inflicts the unity of the earth or not. The kernel of the fact is embedded in geopolitics, and the clarification of the relation between the earth and the political is very problematic for Friedrich Nietzsche:

"The earth", he said, "has a skin; and this skin has diseases. One of these diseases for example is called: 'Human being'". [4], p.103

How should we interpret these diseases? We admit that Nietzsche is criticising the way the Earth was built, precisely the geopolitical regimes that were arranged over the surface of the Earth that required violent deterritorialisation and its reterritorialisation[9]. For Nietzsche, political intervention and its effects establish people in a relation to one another, and those relations have nothing to do with the laws of nature or that of the Earth[10], hence

[4] And Nietzsche uses the landscape metaphors in opposition to their transcendent meaning. Hastily clarifying, immanence and transcendence are positions of different metaphysics. For Deleuze, philosophy must be thought in terms of immanence, as it implies the relation 'in' something rather than a hierarchical directed 'to' something – and that is the transcendence plane (humans are transcended by God, or that mind transcends the body, for instance). Immanence privileges connections over any kind of separation. Deleuze follows Nietzsche's doctrine of eternal return as it provides an ontology of immanence (in *Difference and Repetition* (1968), for instance).

[5] Stephan Günzel argues that their work redefines the utopian structure inherent in most philosophies, transposing to philosophy a spatial force: "[...] in a geographical context that usually persists in the presence of the absence of the place to come. This redefinition consists in the transformation of a temporal structure back into the spatial structure from which, they claim, it originally stemmed". [3], p.78

[6] Geography is not confined to providing historical form with a substance and variable places. It is not merely physical and human, but mental, like the landscape. Geography wrests history from the cult of necessity in order to stress the irreducibility of contingency. It wrests it from the cult of origins in order to affirm the power of the "milieu" (what philosophy finds in Greeks, said Nietzsche, is not an origin but a milieu, an ambiance, an ambiance atmosphere: the philosopher ceases to be a comet). [...] Finally, it wrests history from itself in order to discover becomings that do not belong to history even if they fall back into it [...] "Becoming"does not belong to history. History today still designates only the set of conditions, however recent they may be, from which one turns away in order to become, that is to say, in order to create something new." [2], p.96

[7] That concrete 'incarnation' leads them to conclude that "If there is no universal democratic state, despite German Philosophy's dream of a foundation, it is because the market is the only thing that is universal to capitalism. In contrast with the ancient empires that carried out transcendent overcodings, capitalism functions as an immanent axiomatic of decoded flows (of money, labour, products)." [2], p.106

[8] Admitting here that only capitalism is able to traduce this desire. Capitalism is the philosophical reterritorialisation in its current form: "capitalism reactivates the Greek world [...] it is the new Athens" [2], p.98. And the danger is, it is so planetary. However, modern technology has, as well, a global reach. I will come back to this point later.

[9] Gary Shapiro synthetises superbly the meaning of these fundamental concepts: "[...] people inhabit or territorialize a certain area or space; they deterritorialize by identifying themselves with certain values and norms; they reterritorialize by making the claim that these values "come with the territory". This is the law of their overcomings, by which their habitation becomes a human earth (*Menschen-Erde*)." [5], p.479

[10] And Gary Shapiro also sees this in this way: "So when Zarathustra, a year later, raises the question "Who will be the lords of the earth?" and counsels "be true to the earth," we do not hear him calling for the total mobilization of a state war machine, but as beginning to articulate a geophilosophy and an eco-aesthetics that will not be complicit in the technocratic construction of land." [5], p.492

people will be critics of the laws that have divided what may be permitted and not permitted. And furthermore, as said before, Nietzsche suggests the dissolution of all the inherited forms of history. Henceforth, the geopolitical map must be intersected, abrogated and abolished.

As way of conclusion of this matter, Philosophy, as Deleuze and Guattari avow in 'Geophilosophy', has been too centred on the Hegelian hegemonic vision of history, whereas it should be concentrated on the Earth's entire surface. Even the tropics, following here Nietzsche's claim in *Beyond Good and Evil*:

Does it seem that moralists harbor a hatred against tropics and primeval forests? And that they need to discredit the "tropical man" at all cost, whether as a disease or degeneration of man, or as his own hell and self-martyrdom? But why? In favor of "temperate zones?" In favor of temperate men? Of "moralists"? Of the mediocre?" [1], p.124

Menschen-Erde, or the 'planetarian' man, must be extensive, until the *tropics*[11].

Human unity is fundamental here, although it is an impossible concept since humankind does not proceed from a common origin. Nevertheless, its purpose is to reinforce the supremacy of the Earth and that of the future; that of the perpetual becoming of earthlings, and not that of civilisations.

Deleuze and Guattari's Geophilosophy is complex, and our approach is far from revealing the totality of it. Nevertheless, our goal concerning Geophilosophy is more centred in the *Geo* (Earth) and less in the philosophy. And precisely we would like to underline how Deleuze and Guattari read in Nietzsche the big escape from the local and the mythical, in order to engage the global.

So far, we have seen how Deleuze and Guattari revised Zarathustra's principles. Nietzsche, distancing himself from a historical view, retains geography, geology, meteorology, and calls for a conception of culture based on a *Language on the Earth* [5], indeed that is so because the essential question of geophilosophy is Earth as an object. This, too, is the subject for the Geoaesthetics that Nietzsche intuits in order to reorganise all philosophy from the Earth perspective.

Geophilosophy, in the way it seeks to establish a relationship between thought and planet, should be understood as the horizon of destitutions or restitutions that results from the Earth's elements. Hence, the need for a *new direction for the Earth* (*Sinn der Erde*).

III. GEOAESTHETICS

In his essay 'Nietzsche on Geophilosophy and Geoaesthetics' (2006), Gary Shapiro opens Nietzschean Geophilosophy to Geoaesthetics[12]. In our view, Shapiro underlines a truly essential aspect of Nietzschean *Übermensch* (*Overman*), precisely the constructive character

[11] "The geographical analogy offers an example of a way of thinking that pursues as wide a range as possible of singularities in their series, spectra, and groupings." [5], p.478

[12] Gary Shapiro has other substantial essays on this matters, such as 'Earth's Garden-Happiness: Nietzsche's Geoaesthetics of the Anthropocene'. We will be following 'Nietzsche on Geophilosophy and Geoaesthetics'.

of *Menschen-Erde* (*Planetarian Man*). Geoaesthetics is assumed as the latent purpose of Nietzschean geophilosophy, aiming to build the world from the artist's figure. And all can be artists, when thinking and constructing, critically and creatively through and for the Earth.

By seeing projectively the *new builders* of the Earth, and what a city can be – a new and inventive structure planned and implemented in absolute resonance with the audacity of the artists [5] – a new process underlying creation emerges. Simultaneously, the new builders of the Earth will reflect the landscape metaphors for thought, Earth and the collective, to finally attain the reality of a common becoming. Nietzsche's texts are sprinkled with allusions to architecture and landscape architecture, because he sees in art the way for new land production. Gary Shapiro finds this through the comparative Nietzschean approach to the gardens:

> This is what a city can be, an adventurous, inventive structure through which the daring of its artists is reflected back to them and which also opens out to the wild exterior of sea, mountains, and strange and distant lands. These houses and gardens, the geoaesthetics of Genoa, constitute what Deleuze and Guattari would call a "modern" art, one open to the cosmos as opposed to the "sentimental" or Romantic mode of the English garden. [5], p.492

Although expressed in a different register, this proposition is compatible with Stephan Günzel conception of the landscape metaphors[13], that accords primacy to geophilosophy. But, as Günzel emphasises, whereas Nietzsche's contemporary philosopher Heinrich Romundt demands a *quasi*-theological *geographisation of philosophy* "from which *the philosophy of the future must arise*", Nietzsche will "*use of landscape metaphors in opposition to their traditional transcendent meaning (which as a critic he tried to make immanent to the earth), on the other hand, his philosophical geography is far from geopolitics*" [3], p.87. Besides, Gary Shapiro will enlighten how aesthetics is a non-contemplative attitude in Nietzsche and strongly a constructive and productive way of perceiving the Language of the Earth:

Nietzsche used them to develop a conception of culture and language on the earth, a *Menschen-Erde*. *BGE* [*Beyond Good and Evil*] 268 sketches a conception of culture as effecting a linguistic shorthand for registering the common experiences of a people who have long lived together under "similar conditions (of climate, soil, dangers, needs, and work)." For Nietzsche, as for Deleuze and Guattari, the aesthetic is a significant avenue for exploring the possibilities of earthly life. In contrast with the idealism of Kant and Hegel, and in opposition to Schopenhauer's view of aesthetic experience as purely contemplative,

[13] Stephan Günzel has developed some thoughts around Nietzschean predilection for the topographic and the geographic, by analysing the predominance of the geographical metaphors in the work of Nietzsche. Although Ernst Bertram, Theodor Lessing, Karl Jaspers, pre-war thinkers, have considered that the geographical descriptions of Nietzsche Zarathustra were representations of the actual landscapes he experienced, Stephan Günzel sees the geographical within Nietzschean philosophy. In his essay [3] Günzel lists the types of cases of the geographical and the cosmographic figures in Nietzsche's Zarathustra – the sun, the moon, the sea, the desert, the mountains and the volcano to be used as allegories.

Nietzsche sees the aesthetic as the way in which fully embodied agents affectively respond to and alter their environments. [5], p.480

Shapiro determines Geoaesthetics as a garden theory[14] – which might be suitable for CyberParks, but we will only follow some basic premises here, precisely that of the Earth and that of Geometry (*qua* technics extracted from the Earth). Later we will follow them in the attempt of establishing a *way to a planetarian experience*. But before, and continuing with Shapiro to confirm our previous expectations on Nietzschean geopolitics, the German philosopher is not exhorting to the organisation of a new state apparatus, but rather conceiving the articulation between a geophilosophy and an eco-aesthetics, something that might prefigure a *post-human form of constructing the Earth*:

We can imagine that Nietzsche would be receptive to some of the land or earth art that has emerged since the 1960s, especially in Anglophone countries, insofar as these works redraw the lines of exterior and interior, frame and content, or site and non-site. Some of these may prefigure a post-human form of constructing the earth, some may offer critical perspectives on environmental crisis or globalization [...]. [5], p.492

This may concern the practice of the artist Robert Smithson[15], who in his earthworks develops a scheme around the immense plasticity of earth materials and that of geology. Paradigmatic models for this process is particularly the *Spiral Jetty* – an earthwork sculpture of 460 meters long and around 5 meters wide in 1970 on the Great Salt Lake near Rozel Point in Utah. This installation was documented by the artist in a 32 minute film and in an essay. The 'Spiral Jetty' conveys a kind of a Geophilosophy, since it grasps concepts and establishes conditions for the experience of the Earth[16].

Regarding Nietzschean Geoaesthetics, *Land Art* renders a true commitment for constructing a direction and sense for Earth[17].

Through a Geophilosophy, opened to a Geoaesthetics through the immanence of the Earth[18], Nietzsche appointed to the construction of a new world – as a garden. The *Menschen-*

[14] Shapiro explains that "If a garden is to be seen as a painted composition, then it is already from the outset understood to be a creation of artifice. (It is telling that the English garden is typically constructed by means of a hidden frame, a sunken ditch or ha-ha, which obscures the fact of its framing.) What Burckhardt and Nietzsche admire in the Italian garden is its forthright exhibition of its powerful style, its foregrounding the gesture of the artist. But as the history of the reception of the English garden shows, there is a deep tendency to imagine its aesthetic form as a kind of natural beauty, as when childrenor the naive think of a carefully designed park as unspoiled nature. As Nietzsche's note makes clear, he sees this as a selfdeceptive, sentimental construction of nature. In the language of Deleuze and Guattari, we could say something like this: The state transforms a relatively unstructured territory into land dedicated to measurable production, as it transforms free activity into regulated work, and exchange into a system of money and taxation. The English park, private property of a gentleman, was the result of a general enclosure of common land that forced a peasant population into the cities. It disguises this situation (hence its "sentimentality") by creating the illusion of sheer territory, that is of a pastoral utopia before the threefold apparatus of capture of land, work, and money. In terms borrowed from Deleuze and Guattari's analysis of the refrain, it is a form of the Romantic, but one that testifies to its own fragility and discloses its lack of a people. It fails to be true to the earth". [5], p.491

[15] cf. Gary *Shapiro Earthwards: Robert Smithson and Art After Babel* (1995). Berkeley: University of California Press.

[16] Robert Smithson in his essay 'A Sedimentation of the Mind: Earth Projects' writes: "The earth's surface and the figments of the mind have a way of disintegrating into discrete regions of art. Various agents both fictional and real, somehow trade places with each other – one cannot avoid muddy thinking when it comes to earth projects, or what I will call 'abstract geology'. One's mind and the earth are in a constant state of erosion, mental rivers wear away abstract banks, brain waves undermine cliffs of thought, ideas decompose into stones of unknowing, and conceptual crystallisation break apart into deposits of gritty reason." (quoted in [6], p.116)

Erde (*the Planetarian Men*) is that who builds inventively a direction to Earth in order to rise, collectively and with the Earth, as the *Übermensch*.

IV. BUILDING THE PLANETARIUM

I shall now pursue some questions of Nietzschean resonance for the creation of what might be a CyberPark. As a practice, CyberParks can be accomplished through art (land art, site specific, geo art, global art) by setting an expanded project that imparts both nature, technics, earth and the collective. My attempt could never aspire to exhaust these ideas, but to consider the direction of the earth as a workable and vast territory for Cyberparks implementation[19].

Zarathustra foresees a new World. Through Zarathustra, Friedrich Nietzsche wants both to reveal and assist the beginning of a new effort for humankind: a post human era of planetarian aspiration, possible through what he calls the 'over the human' (*Übermensch*). He is exhorting us to leave the platonic cave and build over the Earth. And it will be by constructing a new sense and direction of the Earth [Sinn der Erde] that humans can overcome themselves.

The way we see this is that technics can provide a planetarian link. The possibilities for the onset of a coherent and truly common organising process lie in contemporary technics, which has a planetarian scale and strength, and incarnates processual reality. To follow this idea, lets turn 'to the Planetarium', a significant essay written by Walter Benjamin between 1923 and 1926.

[17] Simon O'Sullivan regards Robert Smithson works as Geoaesthetics: "It is in this sense of opening up non-human worlds that the film of *Spiral Jetty* is as important as the essay. The film – a kind of geo-cinema – is in fact a construction just as the essay and the jetty themselves are (all involve the manipulation of matter). Through the use of montage, closeups and stills (for example, of maps and charts, of the ripples of the lake and of the sunlight), as well as the different 'view points' of the car speeding through the desert towards the lake, the slow motion and low camera angle of the dump trucks constructing the jetty, and the helicopter's birds eye view over the jetty itself, the film actualises the different durations and different scales at stake in the experience of the jetty, and written about in the essay. The camera then operates here as a machine eye opening us up to worlds beyond the human. [...] We might say then that the film parallels the work of the essay, which itself parallels the construction and the experience of the jetty itself. Each is a component of the *Spiral Jetty machine* whose operative field we might give here a new name: *geoaesthetics*." [6], p.119, 120

[18] "Nietzsche's attempt at a fully immanent thought, involving a geophilosophy and a geoaesthetics has a role to play (recognized by Deleuze and Guattari and others) in thinking critically and creatively about the direction of the earth." [5], p.492

[19] As a practice, still on a very preliminary stage, some attempts were made. Within Cost Action TU 1306 CyberParks, in October 2015 I undertook a Short Term Scientific Mission at Faculty of Architectural Theory of the Technisches Universität Berlin. One important objective of this STSM was to plan artwork possibilities for a *CyberPark*. From the observations we have done during an empirical field research at the Görlitzer Park in Berlin-Kreuzberg, two different directions for the work emerged: the first is called 'The Himmel Palast Project' and the second is called 'Walk a line in the park'. The 'Himmel Palast Project' was highly inspired by the topographical landscape of Görlitzer Park which is characterised by a circular central area that is transversely crossed by a paved path. Our idea is for the redesign of this topographic feature through a construction. Out of the exchange between philosophical consideration centred around the concept of the cosmos and its relation to technology as in the writing of Benjamin, and site-specific and architectural considerations concerning spatial context and design possibilities, this (utopian) project aims to build a spherical structure at the centre of Görlitzer Park, Berlin-Kreuzberg. The globe or dome is conceived of as a temporary construction, the precise design of which in terms of detailing and particular programme remains to be developed in turn with the overall course of the COST action. 'The Walk a line in a park' project is conceptually grounded on Nietzschean Geoaesthetics and was inspired by Richard Long's Walking a line in Peru. Richard Long expanded the idea of sculpture when he 'drew'lines while walking in the Earth's surface. This project has to be done in association with 'CyberParks' app management. The exercise we propose goes has follows: the app user will be encouraged to 'walk a line' in the park. For that, GPS coordinates (or more sophisticated geo-located datasets) of virtual incentives are provided through the app. The idea is on the one hand to experiment with the app as an artistic device and on the other to explore (research-throughdesign approach) the specific conditions of the performative entanglement of virtual and material spaces in CyberParks. For more, see http://cyberparks-project.eu/stsm/visual-rhetoricsmart-cities-between-theoretical-approach-and-artisticpractice.

The instrumental conception of technics reveals nothing of its processual reality. It is by setting a new place for technics in philosophical questioning that Walter Benjamin will develop an important argument concerning technique and nature, and the powerful planetarian hypotheses. This important essay reinforces the outline of the metaphysical collective body that we read in Nietzschean *Übermensh*, and here attained through modern technology. We regard this as highly insightful to apprehend the immense potential for building a CyberPark.

In 'To the planetarium' (first published in 1928), an essay which is still highly influential to apprehend the notion of 'global constellation', Walter Benjamin develops an argument concerning a planetarian *Eros*, where modern technique and the political are intertwined. In the beginning of the essay, Benjamin writes: "*Nothing distinguishes the ancient from the modern man so much as the former's absorption in a cosmic experience scarcely known to later periods"* (p.103). What Benjamin resonates about is that, with the First World War, the cosmos was enacted for the first time, on a planetary scale, through the spirit of technology, while "*the ancients' intercourse with the cosmos* – claims Benjamin – *had been different: the ecstatic trance [Rausch]*" [7], p.103. Men's misreading of technics thus turned a *"bridal bed into a bloodbath*" (p.104). The revolutionary character of modern technic, precisely the global experience, is thus *the way to the planetarium*, because only communally can humans ecstatically connect with the cosmos[20].

Influential for Benjamin's 'Planetarium' might have been his reading of Paul Scheerbart. In Paul Scheerbart's *Lesabéndio: an asteroid novel* (1913), a fantastic parable about the political life of the small planet Pallas is told. Inhabited by creatures of an immense plasticity, the Pallasians – who are *formless*, made out of a fantastic clay which stretches and shrinks in order to see a longer distances along with their telescopic eyes, and their incredible feet that grasp by suction and propel at high speed – smoke pipes in colourful meadows filled with mushrooms. Further on with the oddity, in planet Pallas the skies are violet and the stars are greenish. Amid their highways of conveyor belts and large headlights illuminating the nebulous landscape, a visionary called Lesabéndio conceives a plan for the construction of a tower which is more than 70 kilometres high, a huge project that aims to connect the two stars of Pallas.

And why would an eccentric utopia as Lesabéndio become the central inspiration of a political essay? Precisely that of technics being a solution to an ecological and political crisis.

We are now the readers of the future. We have temporal distance to see the utopian potential of modern post-industrial technology. Here is clearly emphasised the revolutionary character of technics.

In Lesabéndio, and technics and nature do not object[21]. Nor is technics opposed to the pallasians. The inhabitants of that strange planet, instead of dealing with tools to dominate

[20] And Benjamin remarks that *"It is the dangerous error of modern men to regard this experience as unimportant and avoidable, and to consign it to the individual as the poeticrapture of starry nights"* [7], p.58.

[21] According to Gilbert Simondon, technical evolution results from a coupling of humans and nature, where technics is thus the milieu that connects humans with nature cf. Gilbert Simondon *Du mode d'existence des objets techniques* (1958).

nature and reconfigure Pallas surface (like firstly Peka, Labu and Lesabéndio intended), the technological devices are precisely the link that changes the relationship of the Pallasians with their cosmic niche.

In Pallas, the hero Lesabéndio decisively contributes to a consensus amongst all Pallasians. A single purpose unites all of them: they should build a huge tower, large enough to alter the gravitational centre of the planet and trigger changes that would lead to changes affecting the internal nature of Pallasians. When the construction of the great bridge begins, oddly enough, all individual idiosyncratic projects were put aside. All work and effort are to be enacted to a common project favouring a collective and fraternal construction –and the reason of such construction is the planet Pallas itself. In Pallas we find Geoaesthetics, Geopolitics, and Zarathustra:

> Mankind is a rope fastened between animal and overman - a rope over an abyss. A dangerous crossing, a dangerous on-the-way, a dangerous looking back, a dangerous shuddering and standing still. **What is great about human beings is that they are a bridge and not a purpose:** what is lovable about human beings is that they are a *crossing over* and a *going under*. [4], p.7, emphasis added

True politics is represented in Lesabéndio; and utopia. The story tells the intertwining of Pallasians and planet Pallas through technical and artistic designing to reach, ultimately, self-overcoming. Conceiving a new entity, becoming an indivisible whole, Lesabéndio offers his body to accomplish a true *spiritual* superiority: an *Übermensch*. And his sacrifice is thus something Nietzsche praised in *Beyond Good and Evil*:

> The discipline of suffering, of *great* suffering – don't you know that this discipline has been the sole cause of every enhancement in humanity so far? The tension that breeds strength into the unhappy soul, its shudder at the sight of great destruction, its inventiveness and courage in enduring, surviving, interpreting, and exploiting unhappiness, and whatever depth, secrecy, whatever masks, spirit, cunning, greatness it has been given: - weren't these the gifts of suffering, of the disciple of great suffering? In human beings, creature and creator are combined: in humans there is material, fragments, abundance, clay, dirt, nonsense, chaos; but in humans there is also creator, maker, hammer-hardness, spectator-divinity and seventh day: - do you understand this contrast? [1], p.116-117

This is nihilism: only the will that affirms indifference accomplishes the making of a difference that produces being, not by producing being as an object of representation, but rather as a creative power worthy of affirmation. Lesabéndio is a being of becoming who affirms himself by undergoing the metamorphosis. Becoming then expels the negativeness. For Nietzsche, it is through the self-affirmation of the will that the creative power of affirmation is validated, that I read in Lesabéndio as engendering a new and active life and not a reactive death.

Walter Benjamin so wisely identified that technics not only produces new objects but also produces new relations and new subjects[22]. Moreover, with technological individuation[23], new technologies emerged which are related to transmission and circulation and no longer with production, and with these new technological possibilities comes a certain drive for interactivity, an urge for the end of intermediations and a sense of urgency for a general connection.

Only in the situation of a possible global contact, a contact from everybody to everybody supported by technology (a world-wide peer-to-peer), will some of the major challenges and promises of history be solved. It is a collective body that now matters, and this collective body might be attained through modern technics. Benjamin claimed that only through the transductive liaison that modern technics allow, can all humans be connected and commune with cosmos, ecstatically [7]. As way of a conclusion, we point here to the possibilities of a work done by all, with no artist, but done by everyone on the planet. And around major issues that transcend even the biggest questions history may have posed. The only question is Earth. *We are on Earth and there is no cure for that.*

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[22] Cf. Walter Benjamin 'Das Kunstwerke im Zeitalter seiner technischen Reproduzierbarkeit' (1936-39).

[23] It would have been necessary to proceed here with an analysis of the Simondonian question of technological individuation. For more cf. Gilbert Simondon *Du mode d'existence des objets techniques* (1958).

Review and critical assessment on the interaction of urban spaces and technology.

The case of the urban road.

Avgi Vassi
Thanos Vlastos

Abstract – *The road traditionally accommodated traffic but also leisure activities, social activities and even work. However, technology has dynamically entered our lives, enabling us to replicate activities in public that used to be private. It is considered that the lines between public space and private territory, human interaction and human alienation are becoming more and more blurred. The more interaction between digital and physical environments is increasing, the more our cities are changing. This paper intends to explore how urbanisation and spatial hierarchies are redefined by technological transitions. The first part of this research is a literature review, on the studies that concern the interrelation among three key components: people, space and ICT. The second part of this research highlights the proven consequences of technological progress in the shape and structure of the city by studying the evolution and interaction of the urban road and transport technologies (automobiles, highways). This research aims to map the current knowledge concerning the interaction between people, public space and ICT.*

Keywords— public space, urban road, ICT,transport technology,social cohesion

I. INTRODUCTION

Throughout the 20th century, the road, that used to be a space to meet, play games even work, turned into a car traffic channel. However, as technology during recent years has entered dynamically in people's lives, enabling them to replicate activities in public that used to be private, it is considered that the lines between public space and private territory, human interaction and human alienation are becoming more and more blurred. As the interaction between digital and physical environments is increasing, the more our cities are changing. It is considered that spatial hierarchies and "definitions" are re-established by technological transitions. This procedure consists of three key components: people, space and technology.

In this study that focuses in cities, the term "people" refers to the residents of urban settlements. They consist of the majority of the population of the planet. In the first part of this paper, the term technology includes all Information Communication Technologies (ICTs). In the second part, the transportation technologies (automobiles) and infrastructure technologies (highways) are examined.

Regarding the 'public', Iveson [1] highlights the multiple meanings of this term: "it can refer specifically to the state, in distinction to the 'private' market. It can refer to all things

beyond the 'privacy' of the home. People might be spoken of collectively as 'the public'. Getting 'publicity' describes the process of bringing an event or person to the notice of this 'public'." In this paper a public space is considered to be any open space accessible to all people that enhances social interaction. The road is a linear public space in close interaction with built space. As Low et al. [2] believe "A truly public space brings people from diverse backgrounds and classes into contact". Calhoun [3] also supports this opinion stating that "one of the most important social characteristics of cities is the provision of public spaces in which relative strangers can interact and observe each other, debate and learn politically, and grow psychologically from diverse contacts". Public spaces are usually identified as parks, squares, roads, markets, pedestrian areas. Lynch [4] in his attempt to understanding how people see their city, identified five parameters that helped people establish their "image of the city". One of them was the "paths" that represent streets, sidewalks and other spaces of movement. Our research focuses on studying the urban road through reviewing the impacts of transportation technologies (automobiles) and construction technologies on its shape and function.

II. LITERATURE REVIEW

Due to the car, it is argued that the road is changing and is becoming inconsistent to its original use and function. Regarding the public spaces, there are concerns that they are losing their predominant role in urban life [5]. Also Madanipour [6] research on several cities around the globe, also verifies that perception. Across the centuries and through its arious transformations, public space, enhanced by commercial activities, used to represent the main place of communication and source of information and politics. By the explosive growth of ICT, information became easily accessible from home, via the Internet. Sojourning and shopping tend to be partially replaced by online shopping and live communication is often replaced by online forums. At the same time, activities that used to be performed in the private sphere migrated into the public realm. Souza e Silva and Frith [7] reveal that as ICT allowed people to bring traditionally private activities to the public spaces, like chatting or listening to music, the traditional perception of "public" has changed. People began developing a feeling of control and familiarity with public spaces typically associated with private space.

The digital and physical interaction of environments is based on three key components: people, public space and technology. The increasingly strong and complex relation of these, have drawn the attention of several authors that have tried to set light on it, by their own point of view ([7], [8], [9], [10]). A lot or researchers have accused technology of being responsible for not only changing the form of the city but also for the isolation and removal of people from public spaces ([5], [12], [13], [14], [15]).

Technology made building easier and faster than ever, and gave the opportunity for increased control, surveillance and privatisation according to de Souza e Silva and Frith [7] and Iveson [16]. Shaw [17] also agrees with that perception and also adds the

parameter of "digitally collecting, storing, retrieving, classifying, and sorting very large amounts of information" that creates an additional threat to personal privacy.

Meier [18] viewed the city as a place where intense communication processes take place. Under that scope, he claimed that enhanced telecommunications will undermine the cohesion of the city. Stadler [19] points out how the Internet made some activities easily accessible from home, reducing those that take place in the public realm. Although, Hampton and Gupta [20] highlighted "that internet use amplifies the existing trend toward privatism" based on their earliest evidence, but conclude that internet use, generally, reinforces the overall communication.

In the new era of the proliferation of broadband wireless Internet, Hatuka and Toch [21] underlines how technology influences, among other aspects of our life, the use of public space as new behaviors and needs emerge. Riether [22] argues that mobile devices do not favor interaction between people or between people and space, instead facilitate the users' separation from the physical public space. Also the mobile phone, makes a public space less public by enabling people "spending time in private while in public" ([23], [24]). However, having a totally different point of view Hampton and Gupta [20] believe that establishing wireless internet access in public spaces will help tackling privatism.

Stadler [19] also points out that public space can host a wide spectrum of activities by turning the internet into a mobile service and exploring the possibility of using ICT as a tool to increase the attractiveness and quality of public space. Hatuka and Toch [21] conceptualised the "portable private-personal territory (PPPT), a personal space that individuals develop and that is characterised by a multi-dimensional set of social and spatial relationships". It is a combination of digital and material personal space, which does not follow spatial constraints and modifies the role and function of the public space by "enhancing multiple forms of exchange simultaneously". They argue that mobile technologies are not about isolation but about providing traditional public space with communication rituals that were not possible before.

Although the increased interaction with technology has allegedly resulted in increased privatism and individualism, it has also generated, a significant outcome: it increased the gender equity [25]. Women are spending much more time out of home than in the past [26] and as a result they have more opportunities to engage with public spaces.

Literature shows that technological advancements throughout the years have continuously altered space and people's view towards it. Nowadays, wireless internet, cheap data and mobile devices are redefining the social dynamics of public spaces. As a result the lines between virtual and material space are not very clear.

III. THE CASE OF THE URBAN ROAD

During the 20th century, technology has shaped cities through the tech advancements in different sectors. The innovations in agricultural mechanisation led to significant decreases

of agricultural labor that resulted in intense and continuous migration from rural to urban areas. The construction of highways spurred growth in less developed areas. Technology made livable some inhospitable (due to the climate) areas and permitted industries to have more location freedom. Urban sprawl occurred due to the increase of urban populations and to the car and highways. The transportation technologies of automobiles and airplanes are responsible for reshaping cities and regions and for connecting remote settlements/agglomerations with central areas. Car originally created settlements away from urban cores, but its widespread use led to the creation of agglomerations such as the dormitory suburbs. Air travel, train and truck transport reformed regional relationships that allowed extended spread of large-scale urban developments. The development of air conditioning made it possible to live in areas that used to be impossible to live in, i.e. large sections of the south and west of the US. The improved infrastructure of the city (water, sewage and electric systems, highways, telephone) all enabled the reduction of the time people spend in public. Cars enabled a crossing of the public space of the road in an isolated private sphere.

A. Cities for cars

"The cities everyone wants to live in would be clean and safe, possess efficient public services, support a dynamic economy, provide cultural stimulation, and help heal society's divisions of race, class, and ethnicity. These are not the cities we live in." [5]

The car is undeniably one of the most important inventions of all time. It changed the relevance of distances and made accessible areas that were before difficult to reach. Theoretically, every land use could be situated anywhere. The city embraced the automobile and sacrificed to it their form. They became more diffused. Being less dense jeopardised their social cohesion.

Modernism was the movement responsible for shaping cities since the beginning of the 20th century. One of the main principles of modernism was that the form should follow the function, and thus planners ignored the shape of the historical city and concentrated their efforts on facilitating the movement of cars. Moses R., influenced by, and a true believer of, modernism, described accurately the spirit of the time: "Cities are created by and for traffic. A city without traffic is a ghost town..." [27]. In North America, the development pattern was dominated by urban sprawl, strict separation of land uses, single family houses and strong reliance on automobile. The European cities, thanks to their historical legacy, were more resistant towards the car but finally many of them gave up. After the Second World War, and especially during the 1950s and 1960s, European cities started gradually being filled with cars. Highways connected the suburbs with the city center. The life in the city centers downgraded and many residents that preferred living in a detached house and under healthier environmental conditions moved to the suburbs. City centers ended up being crowded during the day and abandoned in the evening when commuters returned to the dormitory suburbs. Public spaces (streets and squares) were transformed into parking lots, new highways were planned, existing roads were widened and through traffic increased.

Urban roads were always considered an essential part of a city's public life: "the street is the river of life of the city, the place where we come together, the pathway to the center." [28]. In the past, roads fulfilled several functions for different groups, such as pedestrians strolling, vehicles moving, children playing and socialising. As Natrasony and Alexander [29] described, "streets became conduits for cars and not people." Expressways were built instead of promenades which were considered by Jacobs [30] as "sacking of cities". She also added that "not TV or illegal drugs but the automobile has been the chief destroyer of American communities" [31].

In this process, much was lost: "the city of memory, of desire, of spirit; the importance of place and the art of place-making" [32]. Cars became dominant of urban life as they occupied the cities. Public spaces turned into corridors dedicated to transport. Transport planning was addressed as a road capacity issue alone. Engineers planned more and more roads in order to respond to the ever increasing demand for car use. As a new road generates new traffic the consequences of this vicious circle are congestion, urban sprawl, accidents, pollution and noise.

Sidewalks shrank, cycling was expelled from the city and pedestrians started feeling unsafe. Intersections, places where normally pedestrians meet, were considered as obstacles for traffic [29]. Sidewalks were narrowed in order to accomplish more vehicle capacity. In the case of existing roads, the carriageway was widened so as to satisfy the need to accommodate more cars. Sidewalks hampered this vision, so in some cases they almost disappeared. The number of intersections for pedestrians was decreased. These interventions increased the number of cars, their speed and removed pedestrians. A vivid example is noted by Natrasony and Alexander [29] who describes the evolution of the city of Surrey, Canada where the "city center has witnessed a dramatic increase in road capacity, and there remains a perception that more expansion is required." In other cases, such as Athens and Krakow, the parked cars occupied even the sidewalks. In Cyprus, the angles of the building blocks became curved in order for the car to turn more easily. No attention was payed to the safety needs of pedestrians. Public spaces turned into parking spaces. During the time that traffic grew into city centers, many cities decided to provide more roads and more parking places. Public spaces turned into parking lots and traffic areas at the expense of pedestrians and Copenhagen was one of the few exceptions to decide to limit car access, by taking away traffic lanes and reducing parking.

B. Cities for people

"For decades the human dimension has been overlooked and haphazardly addressed urban planning topic, while many other issues such as accommodating the rocketing rise in car traffic have come more strongly into focus" [33]. Over the last few years though, the shape of the city has changed and a new vision is dominating urban mobility, as new needs emerge: residents seek not to use their private car for commuting. They use public transport, shared cars, shared bikes and rely more and more on the real-time data provided by their smartphones. In this context, it is expected that pollution, accidents, noise, stress

will decrease and public spaces will regain their identity. This is a vision for the cities for people. A vision enabled by technological advancements.

The road

During the 20th century, for many cities "public spaces" were mainly parks and few other spaces. Roads were neglected and in some cases it was considered absurd to think of them as public spaces as they were surrendered to traffic. This situation resulted in unbearable conditions for the citizens. Thus, many cities started getting away from this narrow perception of "streets as conduits for cars" and "transit stops as simply places to wait" and started paying attention to streets as livable places to stand, sit, communicate and socialise.

Transport planning as well as the shape of streets and roads, including parking lots, sidewalks, transit stops, cycling and bus lanes, road medians, etc., began to be reconceptualised according to the needs of pedestrians and cyclists. Devillers [34] highlighted that the process of designing road space is the process of giving back space to users who were until then excluded. Sidewalks as the "place we come together" [28] should be lively places, well designed and in humane dimensions.

Communities gradually changed their vision towards public space. Transport planning stopped addressing the vehicle capacity issue alone but aimed at making cities accessible and creating favorable conditions to achieve economic productivity and social engagement.

Roads are meant to be for all: lively shared spaces that accommodate vehicles, elderly, children, cyclists, parking, etc. Jacobs [35] describes that a Great Street is "markedly superior in character or quality", comfortable, safe and visited frequently by people and contributes to community feeling, encourages participation, is remembered as a landmark and is representative of a community.

Designing roads for all means creating open spaces, tackling social isolation, supporting transport equity and connecting communities to public spaces. It is proved by the examples that follow that well designed roads can reduce a family's dependency on the automobile, as children can safely walk to school. They connect commercial districts to neighborhoods, and they contribute in building a healthier lifestyle by increasing the potential to walk or cycle. Widening sidewalks is considered a transport solution that decreases speed and greatly enhances activities in the public realm. La Rambla is "a street clearly designed for people to be on, to walk, to meet, to talk" [35]. The transformation of Times Square aims at providing additional public space for pedestrians and events, and transforming it into a world-class "piazza". Praça do Comércio, the waterfront of Lisbon, used to be a parking lot but has recently been renovated and given to the public. There is no parking or traffic, except for trolleys, trams and taxis. The river banks of Lyon have undergone a transformation that turned the parking space along the Rhône to a public space for relaxation and socialising that encourages residents to use sustainable transport options. Streets are gradually unlocking big potential and technology could enhance them, through technology

enhanced urban furniture, in order to give citizens the opportunity to deal with the city itself in a closer range.

The means of transport

During the last two decades, proliferation of digital tools has changed the way people meet, get information, access knowledge and navigate (Figure 1). These technologies rely on networks, sensors, mobile communication, and real-time information. They only now begin to influence urban space. Actually artificial intelligence is increasingly suffusing our cities. It is possible to collect real-time information, seamlessly, on every dimension of urban life. It is considered that digital information is the fuel for a new vision for mobility.

It is possible to collect real-time information seamlessly and on every dimension of urban life. It is considered that digital information is the fuel for the new vision for mobility. This new vision of intelligent transport systems, in effect, consists of intelligent public transport systems, car-sharing and bike-sharing facilities, ride-sharing and self-driving cars. Intelligent transport systems (ITS) point out the integration of ICT with vehicles and transport infrastructure to improve environmental sustainability, economic performance, safety and accessibility.

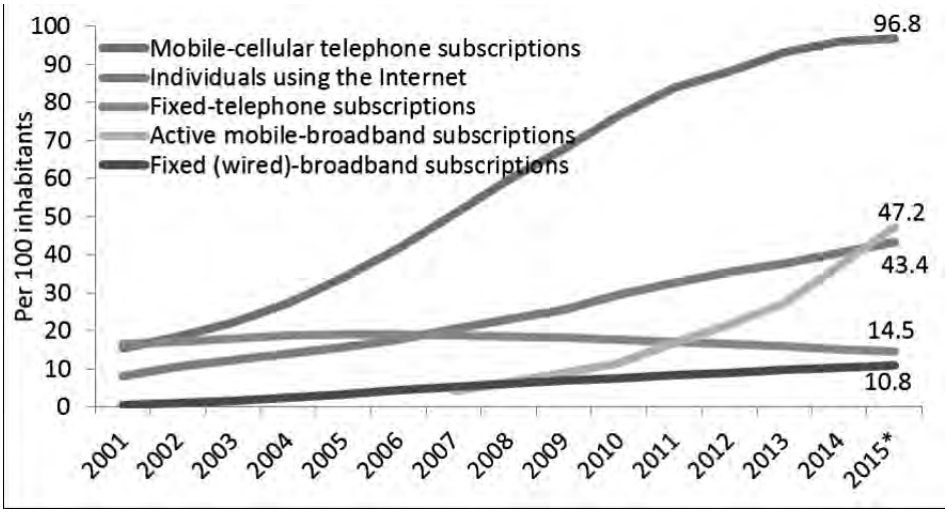

Figure 1: ICT developments per 100 inhabitants (*estimated) *Source: ITU World Telecommunication /ICT Indicators database (2015)*

Intelligent Public Transport Systems (IPTS) aim to provide passengers with smooth transportation, efficient time management and easy access to services. IPTS control public transport networks, assess their performance and provide users with updated (or even real time information) about trips, routes, timetables and traffic disruptions. Mobile services facilitate purchasing tickets and managing journeys.

Car-sharing, bike-sharing

The car/bike a person uses for a ride to work in the morning, would then give a lift to a university student or a group of tourists or to anyone else. People will not own a vehicle but they will share one, whenever needed.

Car-sharing: People spend a great amount of time on the roads, in traffic jams and looking for a place to park. Owning a car requires public space sacrifices that cities have accepted for decades, such as parking spaces at home, at work, at all destinations and space for roadways. Car-Sharing supplements the sustainable transport modes of walking, cycling and public transport – thus providing an alternative to car ownership without restricting individual mobility. With Car-Sharing as a market-based service, transport can be organised more rationally and more resource efficiently, reducing the parking needs [36]. The proliferation of wireless internet and mobile devices enabled the bloom of car-sharing companies through real-time GPS tracking and sharing.

Bike-sharing is considered to be an excellent last mile solution but they are also beneficial for cities trying to introduce cycling. Indeed, in many cities, the use of private bikes has increased significantly after the introduction of a bike sharing system. This positive result improves if the connection between public transport, public bicycles and private bicycles offers a complete and comfortable transport chain for the user's destinations. It is noteworthy that BSS increases public awareness and the acceptance of cycling as a mode of daily transport [37]. Moving from the 2nd to the 3rd generation of bike sharing systems was triggered by technological advancements: use of mobile phones, magnetic striped card and smartcards. The next generation (4th) is being even more tech dependent: stationless (free-floating) bicycles with GPS that can be detected and unlocked through smartphones.

Self-driving cars

The networked era has just begun, showing its potential by launching the self-driving car. Although various aspects of these cars (adaptive cruise control, automatic parallel parking, and collision warnings) are already used in a wide spectrum of conventional cars, it is the first time that these technologies are entering/influencing urban space so dynamically. As it was mentioned before, real time information can be collected seamlessly and thus sensors inside the car can catch drivers' stress, fatigue, sleepiness, and galvanic skin ([38], [39]). Radar, cameras and laser scanners overview the environment outside the car and act accordingly. Self-driving cars also combine the positive aspects of carsharing with those of carpooling as one car will be able to give a lift to multiple persons. Autonomous vehicles used in everyday life are seen mostly in the context of challenging the very notion of car ownership. Private cars, although they offer the convenience of having access to them whenever you need, are too expensive for the society if we take account that they stand idle, on average, 96% of the time [40]. A recent study proves that "under a ride-sharing configuration supported by high-capacity public transport and modelled over a 24-hour weekday, 90% of vehicles could be removed from the streets while still delivering nearly

the same level of mobility as before in terms of travel origins, destinations and length of trip" [41]. On the other hand there are those who are being skeptical towards self-driving cars, either for reasons of interest or due to a different point of view: a resurgence of urban sprawl, traffic jams, increased parking space requirements [42]. The big challenge is whether self-driving cars will be shared or private. The first scenario will be beneficial for the vision of the sustainable city and the second one disastrous.

IV. CONCLUSIONS

Regarding the future of cities, research has tried to propose answers as it concerns the technological impacts in urban life. There are researchers who are afraid that technology will tear the cities apart and those who can see hope in favoring a shift towards increased communication in the public realm. We can also consider three periods of thinking determined by the technological developments: the one prior to the internet, the internet era and the wireless network and, thirdly, the mobile devices era. The wireless network era can be branched in two subcategories according to the price of data.

Considering the pillars of the review it is difficult to fully address and explore their constantly changing relationship. It is difficult to predict how it is going to evolve as it would be equally difficult to predict in the 1930s or 1940s how cities might lose their traditional structure due to the automobile. Although, it is often indicated in the literature that due to technology people are detached from public space, there is evidence that communication still exists and expands, it is just based in new ways of interacting that is different to the traditional, socio-spatial representations. As new needs and possibilities emerge due to technology, isolation is the first layer of interpretation that studies provide. A second, more profound concept, is understood when conceptualising communication and interaction with no spatial constraints but with multiple simultaneous layers

Concerning the case of the road, cars provoked radical changes in employment patterns, social interactions, infrastructures and goods distribution. Streets became thruways to and from the workplace. This occupation by cars and negligence for people resulted a city with noise and air pollution, no green spaces, no social cohesion, with citizens with obesity, health problems, high rates of accidental death, with urban sprawl and decay. On the one hand, these new technologies drove the emergence of more dispersed cities having consequences on the urban and human environment but, on the other hand, spurred growth in less developed regions.

The new vehicles' technology is supposed to reshape transportation and land consumption in cities. Many questions and challenges arise regarding the implications: what will become of public transport? Is ride-sharing and car-sharing driverless cars a new form of mass transit? Should investment in public transport infrastructure be halted? Will the new system work for people with disabilities or those on low incomes? What are the implications for property owners, construction and planning? What will become the land now used for parking? Can the legislative framework correspond to the upcoming changes (planning

laws, vehicle insurance laws, etc.)? What will be the shape of the city of tomorrow? Who will benefit and who will lose? Do all these changes contribute making the cities more socially homogeneous and livable?

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CyberParks Project, funded by the European Cooperation in Science and Technology Programme | COST TU 1306 - www.cost.eu/COST_Actions/tud/TU1306), is a collaborative research platform for knowledge and experiences exchange on the role of Information and Communication Technologies (ICTs) to promote participatory urban design processes and the production of inclusive public open spaces. CyberParks is devoted to explore the contribution of ICTs to transform our cities into more social environments, rather than just more high-tech.

In April 2016 CyberParks organised the mid-term research event **ICiTy - Enhancing places through technology**, in Valletta, Malta, focused on the opportunities and challenges to public spaces brought about by the advancements of ICTs. The conference provided an excellent opportunity to synthesise the current 'state of the art', which is now reflected in this collection. It presents interdisciplinary perspectives, analysis of new methodologies, new theoretical or conceptual models for the digital era, as well as preliminary studies of peoples' use of, and engagement with, technology in public spaces.

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