INTELLIGENT PLANS FOR INTELLIGENT CITIES

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Abstract

The concept of digital city has been evolving since the 1990s towards the formation of a knowledge society enabling the exercise of citizenship through different types of participatory processes and levels of involvement in city planning. This is made possible by the amazing volume of information that is now available to all, supported by Information and Communication Technologies and the growing field of Intelligent Systems. The concept of intelligent cities (IC) is related to the notion of collective urban intelligence that can be enhanced through different factors: learning, innovation, organizational capacity and leadership or creativity and competitiveness. The four challenging topics of evaluation, governance, intelligence and complexity are used to introduce the concept of intelligent plan (IP) as a cornerstone to IC. Using a three level approach (planning process, plan and territory) crossed with the planning evaluation timeline (*ex post*, ongoing and *ex ante*), the authors argue that the Intelligent Plan should take advantage of ongoing evaluation and monitoring, should preserve memory, have ability to display visions into the future and allow for strong interaction between local authority (the plan owner) and urban actors. Applying the attribute "intelligence" to cities and urban plans and its quasi personification as autonomous and living entities, which do not necessarily presuppose automation, is seen by the authors, above all, as a way of instilling reflection.

The article seeks to explore the attributes of IC, bringing new digital "faces" for IP and its future contribution concerning planning challenges derived from IC. Such a plan is highly dependent on Information and Communication Technologies (ICT) and Web-based-GIS which are seen as important drivers for enhancing interactions between citizens, planning process and city governance, improving a participated policy making and urban design and the effectiveness of plans and planning according to the intents of an increasing intelligent city that continues evolving and adapting.

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1. Introduction

'Intelligent Cities' and 'Smart Cities' are the present concepts that succeed to 'virtual cities', 'digital city', 'informational city', 'wired city', 'telecity', 'knowledge-based city', 'electronic communities', 'flexicity', 'teletopia', 'cyberville', among others, covering a wide range of electronic and digital applications related to digital spaces of communities and cities.

The label 'smart city' is used by the World Foundation for Smart Communities (http://www.smartcommunities.org/) to address the 'smart growth' issue. Here development is based on ICT and 'Smart Communities' are communities that have made a conscious effort to use information technology to transform life and work within its region in significant and fundamental ways. The concept of 'smart city' turned out to be popular and has been generally adopted by many cities, business industry and urban marketing, having had echo in the scientific literature of urban and regional studies and policy development, even in the EC and OECD initiatives. There have been some relevant efforts to address the concept (VUT, 2007) - structured on smart economy, smart mobility, smart environment, smart people, smart living and, finally, smart governance - anchored to traditional regional and neoclassical theories of urban growth and development, competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and the participation of society members in cities.

Intelligent cities (IC), (communities, clusters, regions) were defined as multi-layer territorial systems of innovation (Komninos, 2009) that bring together: a) knowledge-intensive activities (the intelligence, inventiveness and creativity of the individuals who live and work in the city, widely explored by Richard Florida (2002)); b) institutions for cooperation in learning and innovation (the collective intelligence of a city's population allowing capacity of human communities to evolve towards higher order complexity and harmony, through differentiation and integration, competition and collaboration. (Atlee and Pór, 2006); c) and digital spaces for communication and interaction (the artificial intelligence embedded into the physical environment of the city and available to the city's population) in order to maximize the problem-solving capability of the city. Komninos (2002, 2009, 2011) states that the distinctive characteristic of an intelligent city is the high performance in the field of innovation, because innovation and solving of new problems are representative features of intelligence.

Smart city literature and research seem to put more emphasis on embedded systems (Steventon and Wright, 2006), sensors and interactive media, while intelligent cities rely more on collective intelligence / collaborative intelligence, innovation systems, and web-based collaborative spaces. In literature the concepts of smart and intelligent tend to overlap and try to integrate the three dimensions of urban space (physical, social, and digital), thus having strong similarities. Some authors sustain that 'smart city' is still quite a fuzzy concept (Caragliu et al, 2011). In addition, the

issues associated with Urbanism, Planning and the physical organization of the city and territory have not been properly considered. Likewise, the future shape of planning tools that currently do not address the increasingly digital dimension of urban space has been out of the scope of the literature. There is an apparent lack in smart city literature concerning the physical side addressing urbanism and planning functions. Hollands (2008) report some problems: the splintering urbanism (fragmentation and polarization, economically and socially); growing contrast between creative classes and IT illiterate sections of the population; social inequality and urban gentrification; conflict between environment sustainability and economic growth. Hollands argues for a more progressive smart city that might use ICT to enhance democratic debates about the kind of city it wants to be and what kind of city people want to live in – a type of virtual 'public culture'.

In general, this debate has gone alongside planning practice and plans ignoring its influence in urban development. In all countries urbanism and urban planning have their own idiosyncrasies and go side by side with the legal system of planning in force. In Portugal it is well rooted in both public opinion and the media that urban planning (and in general spatial planning) is a problem that remains unsolved. In many countries, the plan is still an important instrument in the practice of planning, guiding private and public initiatives and more recently supporting public participation and strategy building, in spite of many criticisms that have forced a progressive shift from planning to process and to the improvement of city governance. And the question remains: What is the role for urbanism, urban planning and plans regarding the future IC?

Rephrasing Hollands' statement concerning the need for a 'virtual public culture', we would appeal for a 'virtual planning culture' enabling a more progressive intelligent city that links urban planning and society. This would mean also a less pro-business city, with smart (quick) and traditional reactive attitude from policy makers but a city that has a medium- and long-term policy agenda. For our purpose this is a good reason to differentiate smart city from intelligent city.

This requires different planning practices but also a different planning product (a different Plan) better adapted to an increasingly digital urban infrastructure that here and there is already including some smart devices embedded in the urban environment (e.g. the Intelligent Transport Systems), but also an increasing amount of urban information made available online and instantly – the ubiquitous city (U-city) - where virtually everything is linked to highly connected information systems (see Choi, 2010).

Within this paper we intend to explore and discuss a new type of plan for cities - we have called it an 'Intelligent Plan' (IP) - as the cornerstone for the future Intelligent City.

2. Four challenging topics for the planning process - evaluation, governance, intelligence, complexity

This notion of a new plan format better adapted for intelligent cities is our provocative starting point that triggers, at least, two questions. The first is "Does the Intelligent City need a plan?" and the second is "If the Intelligent City needs a Plan, what type of plan is it?".

In fact, we believe that an intelligent city still needs a plan. Or better than this, it still needs planning. And planning process should give form to urban development strategies. It is important to state these strategies and, sometimes, to give them an urban form, usually with some rules and to promote public participation and public agreements with stakeholders and community. So, we need to express all this in a plan that acts as a public contract. We also need a plan to promote public participation and to assure transparency to planning process. However, in the context of intelligent cities, this plan should be more interactive, informative and self-explanatory. We have considered four topics that should be the basis for the discussion about the intelligent plan: evaluation, governance, intelligence and complexity.

2.1 Evaluation

There is an extensive literature concerning evaluation in planning (Oliveira & Pinho, 2010) that has been giving useful insights to improve plan making. The traditional timeline of evaluation - "*ex post* evaluation" (what has been done, how, why, by whom), "*ex ante* evaluation" (what should be done considering what is going or is expected to happen), the "ongoing evaluation" (a type of evaluation that takes advantage of plan monitoring and that allows for changing the course of things in time) – can be a first framework to consider. Lessons learnt from *ex post* evaluation practices (Lichfield & Prat, 1998) put the accent on the preservation, as complete as possible, of planning process memory, including previous plans, strategies, options, their implementation and results. *Ex ante* evaluation, the most and more widely explored type of plan's evaluation, puts the accent on the ability to anticipate change allowing for the *a priori* evaluation of the plan and its components. Finally, ongoing evaluation (or "*in continuum* evaluation") and monitoring (Silva, 2006) place the emphasis on the planning process that produces and takes advantage of information (that is being produced and stored, namely through monitoring indicators) and has the ability to process that information in order to give inputs to plan improvements and adjustments in the course of plan implementation.

Conformance and performance principles (Mastop & Faludi, 1997) should also be considered. The first uses a framework of explicit intentions and plan objectives that should be structured in order to be compared with results that are being obtained. The performance principle is better oriented to plans with a strategic dimension and uses different criteria to assess the plan success, such as the utilization of the plan by the community and as a frame of reference to decision making. Planning rights, explored

by Alexander (2002, 2007), are dependent on a specific institutional context but should also be considered as important key-points to ensure a lower threshold of quality to plans, namely as far as public participation, non-discrimination, human dignity and social and distributional justice are concerned.

In a few words we would say that the intelligent plan has to consider the rationale for what, and for whom, it will be evaluated on its own course of implementation favoring an ongoing evaluation process, by planners, politicians and the community.

2.2 Governance

Governance has been an issue of strong debate and has an extensive theoretical literature on which to draw. According to Santinha & Anselmo de Castro (2010) this has led to several reforms in public administration and in the delivery of public services. The growing awareness that governments need to interact with society at different levels in order to tackle the emerging challenges has enabled city governance to involve all informal and formal actors in policy design, decision-making and delivery, with high levels of interaction with citizens, socioeconomic agents, and other public institutions. The emphasis has moved from the power to decide to the power to transform through an active multilevel cooperation. Within this process ICT may have an important role to develop innovative solutions and improve governance mechanisms to reduce deadlocks, conflicts of interest or differences in attitude arising among stakeholders, which are very common in territorial arena. Van der Meer & Van Winden (2003:412) describes 'e-governance' as "the capacity of local administrations, in a dialectic exchange with social organizations, citizens and firms, to deploy ICT to achieve urban policy goals" and discern that access, infrastructure and content form a 'local digital flywheel' for the local information society.
Santinha & Anselmo de Castro (2010) present four levels in ICT use by local/ regional governments in their governance mechanisms: a) passive and unidirectional provision of web information – the technology is used as means to facilitate information delivery, namely cartography or land use plans, and other services of general interest located within its geographical area, namely in the field of health, education and tourism; b) ICT use for interaction and transaction purposes with citizens and other institutions, namely the submission of forms, payments, or the issuing of licenses and permits; c) the use of ICT in promoting interaction with citizens and other institutions so that full participation in policy design and decision making is granted; d) ICT used to bring many participants into the public policy domain not only in providing all technological and organizational means available for the full participation of citizens and other institutions, but mostly in developing complementary initiatives to provide people with, on the one hand, the necessary know-how to understand the utility of and have the willingness to participate in public policy design and decision making and, on the other hand, the needed mechanisms to organize collectively and therefore increase their capacity for participation and mobilization towards collective aims and interests. The same

authors have analyzed three Portuguese case-studies that can be located at the third level, being the fourth level the most difficult one to achieve.

2.3 Intelligence

Considering the urban planning context, 'intelligence' is derived from 'information' and "planning intelligence is strategic decision-support information that enables the planner and the community to identify, understand, and deal with new and trying situations" (Kaiser et al, 1995). Its foundation is an information system, which rapidly evolved with computers to what is known as Planning Support Systems (PSS) (Geertman and Stillwell, 2003; Batty, 2007). The massive use of GIS and Web-oriented ICT had also an outstanding development. Google Earth and systems alike boosted the 'virtual city' concept. Visualization and web based contexts are viewed as the future driving forces for PSS (Batty, 2007). Systems of Monitoring Indicators had a huge improvement in last years to monitor urban change and assess policies, planning and plans (Innes and Booher, 2000; Hoernig and Seasons, 2004; Wong, 2006) improving access to data, to its meaning and to better urban knowledge. As mentioned by Santinha & Anselmo Castro (2010:82), "if knowledge is the engine and information the fuel of economic development, ICT can be seen as driving the innovation process".

The intelligence of cities is intrinsically linked to data and information which are increasing in quantity and quality. Intelligent cities tend to require more collaborative and collective intelligence and new discussions concerning spatial intelligence are being presented in literature (Komninos, 2011). In any case, cognitive psychology could give good insights to discern about the intelligent city.

The future format of plans for cities will be digital and web based. And the main interrogations concerning plan making will be centred on tools made available to increase and develop that collective intelligence and on their different attributes and dimensions, to improve a more participative attitude, on information to trigger urban creativity and on governance tools to explore artificial intelligence and modelling.

2.4 Complexity

Cities and society are complex by nature. Recent developments concerning complexity theory try to uncover its mechanisms: urban long term evolution, path dependence, emergence, feedback, self-organization, resilience-adaptation among others. The main efforts in different scientific areas concerning the complexity of cities are centred on understanding fundamental principles governing global behaviour of these urban systems, expressed in terms of many dimensions (namely physical, ecological, economic and human) related to interactions and resulting patterns and structures that collectively define system responses. There have been many studies interested in local interaction between parts giving rise to an emergent global order, "the order out of chaos". This recognizes, somehow, the virtues of bottom up dynamics that have led to enhance participation in planning and the use of

collaborative planning practices as a means to reinforce the self-organization and self-adaptation power of cities. But in our point of view this is illusive if we think that those practices can lead to waive the plan, as a planning tool to organize cities. Alexander, Mazza and Moroni (2012) explained recently very well why we still need rules, and consequently, why we still need plans. Portugali (2011) also stated that the notions of complexity and self-organization are not in opposition, as apparently they seem to be, with the notions of planning and urban design, highlighting the importance of spatial cognition where planning can be at once a cognitive capability of humans as individuals and collectivities.

We are certainly far from the time when the Intelligent City would resemble a self-planned city, expression used by Portugalli (2011) which would require a new and different structure of planning and perhaps new planning authorities. But we cannot continue to ignore the role of models, simulation, technology, information and multiple types of communication in the organization of the city, which do not fit in the traditional and common format of plans. The "Intelligent plan" can be a first step to recognize and start to deal with the complex nature of cities in spatial planning.

3. What can be an Intelligent Plan?

Our problem to be investigated is centered on the fact that the present format of plans to cities does not match with the future intelligent city and it does not take advantage of ICT and digital space in urban societies. Despite having evolved into more dematerialized versions, made available on the Internet, these formal plans remain stuck to the traditional paper format. They remain static, generally blind without visual representations of the planned reality, rigid in time, with low interaction with people after plan adoption and difficult to interpret concerning the proposed changes to the antecedent plans. Therefore, the challenges are to design a new plan framework that can be adopted and web based, taking advantage of three types of Intelligence – Human, Collective and Artificial - in order to prepare better adherence/adaptation to the future Intelligent City.

This new plan format – the Intelligent Plan (IP) – is a challenge to scientific research because it seeks to overcome different problems. In the scope of intelligence we can devise the problem of information systems (openness of data access to different users and applications, uniqueness of digital applications and fragmentation of planning activities, tools to automate urban analysis and management). In the field of evaluation in planning there is the problem of structuring and preserving old plans, past planning options and policies, results, practice and urban change (spatial memory). Looking to the planned city there are problems such as those of visualizing intermediated stages of city being changed and simulating the planned city that is being built to evaluate its performance (self-explanatory power). Complexity leads us to understand the long-term evolution (memory) of the city and implies paying attention and favor bottom-up emerging behaviours from citizens and organizations which, in turn, recommend us to create mechanisms for communication and public participation. From the governance side different problems emerge: the interaction models between urban actors/ population and decision makers and planning

authorities to be embedded in IP; the automation of approvals and authorizations of land use changes and its public disclosure through the IP; the creation of automated tools to monitor policies, namely through monitoring indicators, dashboards and management tools.

The almost personification of the IP as an autonomous and living entity will be used in the context of this paper to help us think about its meaning, functions and main attributes.

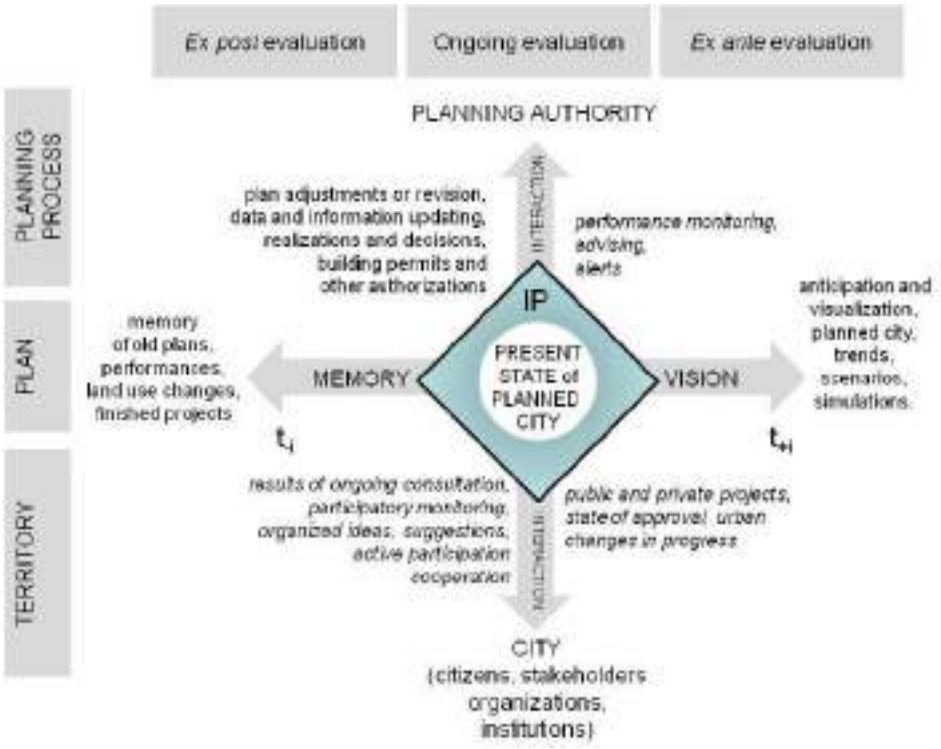

Figure 1 – the Intelligent Plan (IP) as a communication tool for planning authority and for urban actors concerning the past, present and future state of the intelligent city.

The attributes of the IP represented in Figure 1 cross the traditional timeline of evaluation types (*ex post*, ongoing and *ex ante*) with three evaluation levels – the Planning Process with strong interaction with the planning system - styles of planning, legislation, planning authorities and planners – with the formal Plan itself and the Territory (the city) that receives the influence of the Plan but has its own behavior and transformation mechanisms.

A second line of thought (Table 1) will try to link the IP with the idea of an IC which is expressed in Table 1. The attributes identified on the first column are based on extensive literature produced about IC and cognitive psychology, taking into account that the intelligent city is a collective and evolving body with similarities with human

intelligence attributes. In the second column we try to expand potential contributions that IP can give to IC. The type of IP considered here is based on the common functions envisaged for urban planning to structure, organize and prepare cities for future times.

Table 1 – Contributions from the Intelligent Plan to the Intelligent City

Attributes of the Intelligent City	Intelligent Plan
Intelligence (collective) / Education	
• Urban Knowledge and Learning • Problem solving and the construction and use of urban tools • Collective thinking (reasoning) • Mental representation (abilities of abstraction, generalization, interpretation concerning city)	• Repository of old plans, preservation of memory related to past planning process and past performance and evolution of city • Self-explanatory power (language) concerning policies, planning options and measures adopted • Takes advantage of Internet and augmented (mediated) reality through ICT devices to show urban changes (land use change, new public projects or private buildings) in progress or planned for the city. • IP has enhanced capabilities of representing virtual city being changed and planned, relating urban models, structures and abstractions to land use maps and proposals.
Communication	
• Takes advantage of digital infrastructure (ICT), physical space (public space, sustainable mobility) and public services (sustainable transportation) to fuel quality of life for all and develop human and social capital; • Urban open systems (available formats and open data to the creation of apps) and sensor networks • Ensures access for all social groups and organizations and enabling wide interactions • Stimulus to simplification, transparency and new public e-services; • Enables the relational capital of cities (among citizens/organizations and between cities).	• Offered as an ICT technological platform that relates local administration to citizens/organizations/ companies • Promotes and organizes public participation to different planning purposes (auscultation, hearing, partnership, collective deliberation, etc.) • Requires integration with urban planning and local urban management services (e-governance). • Gives and collects data that can be used and interpreted by urban actors • Displays benchmarking data, performance indicators and comparative analysis between cities on the course of plan implementation
Relational capability	
• Promoting human and social capital enabling social relationships among citizens and the expression of their emotions concerning city and urban life • Ability to relate to other cities	• Integration on (or integrating) local social networks
Creativity / Innovation	
• Entrepreneurial capabilities; • Inventiveness of individuals, organizations, institutions and companies • Openness to experimentation	• Providing office spaces, support services, financial backup and urban environments to nurturing creativity and innovation • Launching challenges and interpellations trough the plan to the community to solve problems or uncover solutions • Acceptance of temporary (non definitive) or

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	experimental solutions by planning and planners and its formal inclusion in the plan
Healthy growth	
• Promotes a balanced metabolism and sustainable growth (production and consumption of resources and energy, green and social economy) • Ability to care for itself (social inclusion, territorial cohesion, preservation of social/ common services and supporting deprivation) • Balancing competitiveness/collaboration • Balancing differentiation/ integration • Seeking diversity (in all dimensions) • Capacity of adaptation (adaptability/ resilience) • Ability to reproduce itself.	• IP includes knowledge about the urban metabolism and measures of its evolution • Promotes diversity of urban typologies and urban ambiances • Promotes diversity of housing solutions for different social groups, taking into account the lifecycle of families in neighborhoods • Anticipates the risks and develops contingency programs and solutions • Enhances adaptability (resilience) of city and avoids a complete allocation of uses and a total definition of land use, accepting uncertainty and bottom-up initiatives. • Promotes city growth by multiplication, not by increasing its size, developing cities within the city and polycentrism within the system of cities.
Self-organization and wise management	
• Rules and self-control • Self-evaluation, monitoring and warning systems • Leadership and democratic governance • Stimulation for public participation • Enables an organized participation	• IP includes more flexible regulation, more agile in changing (improving) planning rules and developing stochastic norms that are triggered when a certain condition is met • IP offers information and interactive tools to more knowledgeable governance about population needs and desires. • Feeds leadership allowing for a participative monitoring • IP can open decision spaces to public discussion and deliberations • IP can offer some automation concerning mature methodologies of urban management (e.g. Urban Development Charges, land taxation, etc.).
Intentionality	
• Ability to develop common understandings and a collective consciousness (social, cultural, environmental and urban) • Structure future intentions, policies and take action • Ability to progress for long term planning (sustainability)	• Shows clearly the intent structure and how the objectives and strategies evolve in time with the successive revisions/ alterations of the plan (conformance) • Can automate (performance) levels of participation/interaction and how the IP is acting as a reference system to decision making • Can include monitoring dashboards, and offers simulation tools to anticipate configurations/ visions for future states of the city and its *ex-ante* evaluation.
Finality / Purpose	
• Creating citizens and develop citizenship, which allows collective thinking about the future of their city, what and how can be achieved and developing common strategies to get there.	• The IP should feed citizenship

It is our conviction that such IP should have, at least, the main following attributes (Figure 1):

Memory - preserving old/previous versions of plans, their objectives, options, realizations and performance and also previous images of city and its past transformation.
Vision – powering to anticipate urban change and visualize the future planned city, its trends and visual simulations concerning strategic projects.
Interaction capability – interaction with the city actors promoting consultation, enabling active participation individually or collectively organized, allowing to post individual initiatives or even private projects in order to an automated preliminary approval; interaction with the planning authority and the planning process in order to make possible plan adjustments or revisions, updating data concerning administrative and management decisions or including performance results using dashboards and monitoring indicators.
Self-explanatory power – presentation of an updated view of current state of city and all data/ information related to approved land use changes and building permits; showing an updated image of the virtual city that is being built which should be available to all the community; including clear explanations and justification of planning options using ICT concerning urban design, urban structure and regulations.
Reasoning – allowing collective thinking which may include graphical representations and mathematical formulations, capabilities of urban modelling (and some sort of artificial intelligence) in order to anticipate impacts from private actions or from public decision making and warning systems, namely those alerts concerning performance of plans and their objectives/ targets.

Vision and *Interaction* are in line with the two main performance strategies to increase the success of plans, following the main functions that plans should fulfill (Needham et al, 1997): the "vision model" where the attractiveness of the design is crucial but have to be perceived visually in all its multiple dimensions; the "consultation model" – a two-way participated process of plan-making. Visioning the virtual city being built or the planned city and scenarios are crucial to formulate and validate urban policies (Ramos, 2010). *Interaction* is a means to allow public participation in plan making and plan implementation. *Memory*, like in humans, is considered essential to build a sense of collective intelligence. The *self-explanatory power* is here assimilated to human language and can be explored in different ways by an IP. The *reasoning* ability pushes the IP to include models and artificial intelligence tools allowing some automation capabilities to support governance and interaction.

4. Conclusions

In Portugal every 308 municipalities have a master plan (Plano Director Municipal-PDM) for their territory and some cities have a land use plan (Plano de Urbanização). A high percentage of them (Santos et al, 2012) use GIS and the presence of the

municipality on the Web is widely observed. E-government had an increased development in Portugal at central and local levels which is internationally recognized - Portugal ranks first in the European tables for the sophistication and availability of its online public services (EC, 2010).
In general, local plans are still produced in paper format but many municipalities offer dematerialized versions in common digital formats (pdf, jpg). The General Directorate of Planning, responsible for the registration of all formal plans in Portugal, has moved to dematerialization and made available all plans in digital versions through SNIT (National System of Territorial Information, www.dgotdu.pt), which was a strong enhancement to the planning system.

Possible evolutionary steps could be, as proposed, to move from simple dematerialization to a plan format implemented as a technological platform, a true e-planning service with tools in front-office available to community and tools in back-office available to local authorities and planning departments. Therefore, the plan would become: interactive; acquiring and storing data from many sources, integrated with municipal planning systems; with memory concerning the succession of plans; embedded with monitoring indicators that would enable its multi-level ongoing evaluation; serving as a platform of collective communication tool for discussion of "collective hopes" and creation of visions for alternative scenarios and future development; displaying visualizations of the virtual city being planned and built and of the trends of the evolving city and its future configuration; enabling cooperative mechanisms regarding the process of finding and developing solutions; having tools to promote an organized participation process among citizens, public and private organizations; a plan that would promote high levels of transparency, advising and alerting.

An improved digital ICT has strong challenges to urban planning and plans: information asymmetry between citizens and administrations, access of the population to the web, different digital skills and economic and educational levels among the population. The more dynamic nature of such IP may present difficulties to its juridical side where the stability of plan regulations is considered important for the confidence of economic agents. Even the issue of transparency has its limits concerning some aspects of negotiation involved in the planning process. But other challenges related to this transfer from the traditional paper format to the web will have clear positive impacts on collective intelligence and on the planning culture of the city, as many other aspects of the information and knowledge society had in the last two decades.

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