PlanYourPlace: a geospatial infrastructure for sustainable community planning

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ABSTRACT. *Technological advances over the past 5 to 10 years have made Geographic Information Systems a powerful and affordable tool for geographic analysis and urban planning. These technological advances have also enabled and shaped new forms of communication and participation, particularly within the domain of social networking via webpages such as Facebook, Twitter, and LinkedIn. Connecting the analytical power of GIS with mapping tools and interaction capabilities of web 2.0 technologies, as well as with environmental, economic, and social models should result in a promising toolbox for urban planning. This article presents a framework that outlines requirements and constraints for a web-accessible planning platform within the context of sustainable urban development of established neighbourhoods in the City of Calgary, Canada. The platform focuses not only on the urban planner as user, but more specifically on the citizen as a contributor to the planning and development process, to further include public opinion in the planning process. The following three aspects for the implementation of the participatory planning platform are*

addressed: (i) legal framework, (ii) functional objectives, and (iii) technical implementation, and the corresponding literature reviewed.

RÉSUMÉ. Les progrès technologiques au cours des dernières 5 à 10 années ont fait les systèmes d'information géographique un outil puissant et abordable pour l'analyse géographique et la planification urbaine. Ces avancées technologiques ont également permis et façonné de nouvelles formes de communication et de participation, notamment dans le domaine des réseaux sociaux via des pages Web tels que Facebook, Twitter et LinkedIn. La connexion de la puissance analytique de la SIG avec des outils de cartographie et les capacités d'interaction des technologies du web 2.0, ainsi qu'avec les modèles environnementaux, économiques et sociaux devrait aboutir à une boîte à outils prometteurs pour la planification urbaine. Cet article présente un cadre qui énonce les exigences et les contraintes pour une plate-forme de planification accessible sur le Web dans le contexte du développement urbain durable des quartiers établis dans la ville de Calgary, au Canada. La plate-forme ne se concentre pas seulement sur l'urbaniste en tant qu'utilisateur, mais plus spécifiquement sur le citoyen en tant que contributeur au processus de planification et de développement, pour comprendre en outre l'opinion publique dans le processus de planification. Les trois aspects suivants pour la mise en œuvre de la plate-forme de planification participative sont abordés: (i) le cadre juridique (ii) les objectifs fonctionnels, et (iii) la mise en œuvre technique et la littérature correspondante en revue.

KEY WORDS: Participatory Planning, GIS, Web Platform, Social Networking, Framework.

MOTS-CLÉS: Planification Participative, SIG, Web Platform, Le réseau social, Cadre.

1. Introduction

Since the conclusion of World War II Canada's urban population has been growing continuously, with the urban population increasing from 51% to 81% of Canada's total population (Bourne *et al.*, 2011a). Most of this growth has occurred in Canada's major cities, with Calgary, Edmonton, and Toronto experiencing recent growth rates of more than 10% (Bourne *et al.*, 2011b). Looking forward, the City of Calgary projects that its population will double in the next 50 to 60 years (City of Calgary 2011).

In an effort to manage growth during the post war period local Canadian planning policies have tended to promote balanced development within urban areas in an attempt to reduce congestion in urban cores, and to control sprawl. We characterise sprawl as suburban developments that are predominantly single use zones of low density residential developments, office parks, and shopping centres connected by highways that require citizens to depend on private transportation (Brueckner 2000; Miller *et al.,* 2011; Calthorpe 2011). However, this resulted in a Fordist approach (Antonio *et al.*, 2000) to land development (Bunting *et al.*, 2010), and government sponsored Keynes economics (Frazer 1994) that promoted car-oriented suburban development featuring super blocks (Stein 1957) of mono-functional zones surrounded by government sponsored arterial roads (Fishman 1987), widespread home ownership in new communities as a result of a growing middle class and mortgage subsidies for single family homes (Dennis *et al*., 1972), and, sponsorship of dispersed industrial development to promote economic growth (Coffey *et al.*, 1987). Additional consequences of low-density suburban development have been an increase in the urban ecological footprint (Rees 1992), high levels of energy consumption, increasing cost and debt burden of infrastructure and service provision (Simmons *et al.*, 2011).

While economics has held considerable weight when prioritizing urban growth (Barlowe 1986), a holistic approach (Geddes 1968) is recommended, and generally considers economic, social, and environmental aspects of development. As such, all urban spaces have distinctive environments that explain their situation and contribute to their ability to sustain themselves. Following (Filion *et al.*, 2010) there are seven general properties that can account for the existence of cities, how they are organized, and the way that they operate. *Production* is generally the reason why a city exists. Because cities cannot provide all goods and services consumed by its citizens, a city must produce things that can be sold so that revenue can be generated to acquire goods and services that can only be obtained from other places (Watkins 1980). This creates jobs. Many of the job markets within a city overlap with each other, hence, people and activities have tended to congregate in cities because this facilitates communication and exchange of goods and services. This *proximity*, and the interactions that evolve, have often lead to innovation (Hall 1999) and greater production capability. The ability of a city to reproduce, i.e. provide an ample labour force, will affect its ability to produce (Castells 1977). Broadly, *reproduction* depends on healthcare and education systems, public and private services available

to the citizenry (Filion *et al.*, 2010) to enable populations to survive. *Capitalization* of a city refers to investment in its built form. Because land is relatively scarce within a city, its value tends to be higher. This value has a propensity to make urban landscapes more durable, i.e. it is more cost effective to undertake Greenfield development, than brownfield. This gives greater stability to cities (Pierson 2000), but it can also be an obstacle to change (Inhaber 1998). Proximity requires administrative and governance structures that enable smooth functioning of infrastructure and services. *Governance* allows cities to deal with issues related to the concentration of activities and urban infrastructures (Lightbody 2006). In order for cities to survive they must be respectful of their *environment*. If soil, air and water quality are compromised then health issues will likely arise, which has historically made it difficult for cities to sustain themselves (Diamond 2005). Lastly, *place* refers to the subjective attachment that people have with the city within which they live (Tuan 1974). (Jacobs 1961), (Lynch 1964, 1984), (Alexander 1979) and (Alexander *et al.,* 1977) argue that the fundamental principles of place will lead to a higher quality of life and a more efficient use of urban space. The principles of place embrace elements such as: cities function as an ecosystem; cities have a public realm; communities have a mix of uses; cities and communities have well designed centres, etc. It is this last property, *place*, that the PlanYourPlace project will focus on.

It is well understood today that cities have an ecological footprint that is many times larger than their physical footprint (Rees 2008), and consequently many cities are now engaging initiatives to alleviate their environmental impact (Register 2006; Connelly *et al*., 2010). The City of Calgary, for example, established the *Plan It Calgary* initiative, which has resulted in sustainable municipal development (City of Calgary 2009a) and transportation (City of Calgary 2009b) plans that address many of the cities social, economic, and environmental planning issues. Plan It Calgary was adopted by the City of Calgary in 2009 (Miller *et al.*, 2011). Some objectives of Plan It Calgary are the development of a more pedestrian-, transit- and bicycle–friendly city, urban intensification through an increase of compact mixed-use communities, and the creation of a greater range of housing choices (City of Calgary 2009a).

The notion of sustainability often has strong environmental associations. However, the idea of sustainable communities is related to and affected by other factors including urban morphology, social factors, and politics. Of particular interest in this research is the field of urban morphology, or the creation of place as discussed above. There are several schools of thought in morphological studies (Moudon 1997), which, although rooted in different cultural and linguistic traditions and disciplines, share some common principles:

- Urban form is defined by three fundamental physical elements: buildings and their related open spaces, individual parcels of land, and streets.
- These elements can be understood at different levels of resolution. Commonly, four resolutions are recognized, corresponding to the building/parcel, the street/block, the city, and the region.

- Urban form can only be understood historically, because the elements of which it is comprised were formed over time.

Good urbanism requires a certain density, intensity, and mix of uses that urbanists everywhere advocate, but which is difficult to put in place, partly due to the persistence of out-dated land development and planning practices and processes. Good governance responsibilities have led to "*pressure for an expanded role for the public in planning* [that] *is rooted in both philosophical and pragmatic considerations*" (Sewell *et al.*, 1977). There exists a general belief in democratic societies that the individual has the right to be informed and consulted, and to express their views on matters that affect them personally. Consequently, citizen participation became widespread in the 1960s as middle income North America demanded a more active role in environmental and neighbourhood decisions. New skills and new policies were developed so that planners became responsible to citizens through the creation of socially suitable neighbourhoods that incorporated citizen's values. As such, design in the 1960s took on a form of community participation with the professional designer acting as an advocate for groups who ordinarily would not have had access to a design professional, or to the decision making process (Hodge *et al.*, 2008). However, since the 1974 oil crisis the planner's role has shifted to a greater extent towards a bureaucratic role that is often constrained by budget limitations, and complicated by increased complexity of today's planning issues (Campbell 1996; Hodge *et al.*, 2008). This has tended to result in a less well-informed citizenry.

To this end, the PlanYourPlace project was founded to develop an online platform that informs and educates the public of development options, and to further enable participation by the public in the planning process. The project brings together researchers from University of Calgary and the University of Toronto with expertise in Planning, Transportation, and Geomatics, as well as Calgary neighbourhood associations and non-profit community groups, the Calgary Regional Partnership, and several departments from the City of Calgary. The platform will integrate knowledge from five different areas (Figure 1): (i) (Urban) Planning and Transportation, (ii) Citizen Participation, (iii) Geographic Information Systems (GIS), (iv) Internet Technologies, and (v) Social Networking.

The objective of this article is to lay out the foundation of the participatory planning platform, considering the legal, planning, and technical aspects that constrain the project. An important aspect of the framework is that it is not grounded solely within a technical perspective, i.e. what can we do with current tools, nor is it a top-down planning perspective. Rather, it presents a grass-roots approach that sets citizen participation at the center so that they are able to collaborate with government administrators — who might use the system to interpret planning proposals as they reconcile the many competing demands of citizens — and domain experts from planning, transportation, and the environment — who may wish to present relevant information and analyses, or develop methods for design and assessment of proposals. As such, the underlying inspiration for the platform design is that (a) citizens describe their needs and uses of city services and infrastructure,

(b) that they can express likes and dislikes of various development forms as suggested by (Talen 2000), and (c) that this information can be incorporated into one or more design philosophies that can be assessed using various planning and development models so that communities, planners and administrators can also be informed of the possible consequences of a particular approach. With this idea in mind it follows that communication and preference expression tools such as those found on many social networking websites will play an important role in the platforms design.

Before we present the framework for the participatory platform we review the planning literature that describes the kind of functionality planners suggest for a participatory design platform of this nature. We then present the framework and discuss it from three perspectives: legal, user activities; and technical implementation. Later we will review the literature on existing participatory web GIS and models for the evaluation of development plans. Based on this analysis we define a workflow for project and platform implementation.

Figure 1. *The PlanYourPlace project knowledge areas.*

2. What planners want?

It may appear counter-intuitive that we first set the focus of our framework on citizen engagement, but address planner's functional needs first. We have adopted this approach because: (i) planners know what parts of the planning process require citizen participation by law, (ii) planners know how they can use citizen input, and (iii) planners are more likely to use the information if it meets their needs. We will structure the results of our literature analysis, i.e. the planners' functional requirements for the platform, according to (Smyth's 2001) e-participation ladder as discussed in (Carver 2003). We also relate our findings to (Arnstein's 1969) ladder of public participation as well.

The first rung on the ladder is "*online service delivery*," which has been classified as a one-way communication process. According to (Carver 2003) this step includes payment of taxes, and access to government information. Hence, *informing* citizenry of planning projects will be part of this stage. Information is delivered via written documents and images. Sketches, maps and 3-D visualizations of planning projects can also provide insight into a planning project. The need for such basic functionality has been expressed in the planning literature, for example by (Guhathakurta 1999), (Drummond *et al.*, 2008), and (Mandarano *et al.*, 2010).

However, a municipality informing citizens of development plans is not the sole direction that information can flow. As noted by (Talen 2000) and (Drummond *et al.*, 2008), it can be beneficial for information to flow from the citizenry to the planning department for "community profiling", i.e. to understand a community's desires and to identify what citizens like or dislike about their neighbourhood.

Accordingly, the second rung on the e-participation ladder is "*online discussion*," which is a two-way communication process. The possibility of *discussing* (i) neighbourhood issues (e.g. crime or illegal garbage sites) and (ii) planning projects was outlined by (Guhathakurta 1999), (Vonk *et al.*, 2007) and (Drummond *et al.*, 2008). Different discussion media such as e-mail, forums, and chat rooms are possible and have been realized in existing participatory online applications, e.g. in GeoDF (Zhao *et al.*, 2006), ArgooMap (Rinner *et al.*, 2008) and MapChat (Hall *et al.*, 2010).

To reach the third rung of Smyth's participation ladder requires the implementation of "*online opinion survey*" capabilities, which can also be categorized as a two-way communication process. We believe this rung of the ladder includes online-discussions, the ability to rank planning options (e.g. a plan, or other comments), assigning weights to plan evaluation criteria, and the provision of voting tools so that citizens can express their preferences from a set of planning scenarios. (Carver *et al.*, 2001) offer an example that makes use of weighing tools for participatory online site selection: in this case for the selection of a future forest plantation.

Interestingly, voting as an option for citizen participation is not discussed directly in the literature we reviewed. Rather, (Guhathakurta 1999) mentions this function in his analysis of Group Decision Support Systems (GDSS) for planning purposes, and (Talen 2000) speaks in general of the desirability for citizens to be able to express what they like, or dislike, as part of the community profiling and knowledge acquisition process. It seems logical from the author's perspective to have ranking or voting functionality as part of all planning systems. Firstly, good governance rests on an equitable relationship between all stakeholders and a participatory decision-making process (Brown *et al.*, 2003; Lockwood *et al.*, 2010). Secondly, there are explicit requirements found in most planning legislation that the public be consulted. And finally, people have become used to the ranking tools found on many websites, such as Amazon, Facebook (the "Like" button), and Google+. Functions like these present a good way to fulfil legal requirements and elicit equitable participation.

The fourth rung of the ladder, and highest stage of citizen participation according to (Smyth 2001), is "online decision support systems." Such an online decision support system will need to include all the previously discussed participation options, plus the ability to create plans (i.e. *sketching*) and *evaluate* these using impact assessment models (e.g. forecasting transit use, school distribution, fiscal metrics, etc.). According to (Drummond *et al.*, 2008) posting of citizen-generated plans for consideration, i.e. *sharing*, and subsequent discussion, as well as modification of existing plans should be part of any public participation process.

In summary, we have identified that a participatory planning platform should enable the public to perform the following actions: (i) *inform* themselves about planned projects, city planning, and community issues, (ii) *discuss* plans and community issues, (iii) *rank* proposed and official plans, sketches, and comments/suggestions made by other users, (iv) *sketch* and modify plans (i.e. design), (v) *evaluate* proposed plans with assessment models, and (vi) *share* created plans for discussion.

Despite our focus on the citizen as the primary platform user, the actions (iv) sketching and (v) evaluation will also be of interest to community planners and decision makers. Hence, planners and decision makers can also be regarded as users of the participatory platform if they (a) inform citizens by providing supporting documents, (b) discuss proposals with citizens, (c) evaluate citizen feedback (which may require a separate reporting tool set), and (d) use sketching and evaluation functionalities.

An analysis of the planning literature by (Mandarano *et al.*, 2010) revealed that the majority of municipal planning departments only inform citizens – Smyth's level 1, or level 3 at best on (Arnstein's 1969) ladder of citizen participation. Very few municipalities use tools for discussion and feedback (see tables in Mandarano *et al.*, 2010). However, in participatory GIS research, prototypes have been developed for online discussion and decision-making (Smyth's participation level 2, or Arnstein's level 4). We will review existing platforms in Section 4.

3. A conceptual framework for the design of a participatory planning platform

We have established in the previous section the types of actions, or use cases, that the public should be able to perform via a participatory web-based planning platform. This set of user actions can be viewed as a set of functional requirements for the platform – representing one component of the software development framework. However, an implementation of the platform also requires that we investigate the following two questions: (1) what are the legal aspects of such a platform? (2) What are the technical implementation requirements of the platform? As such, the realization of a participatory planning platform requires a framework that encompasses three components: (1) the legal environment within which the system must function, (2) functional objectives, and (3) the technical

implementation (Figure 2). We will elucidate these three components in detail in the following subsections.

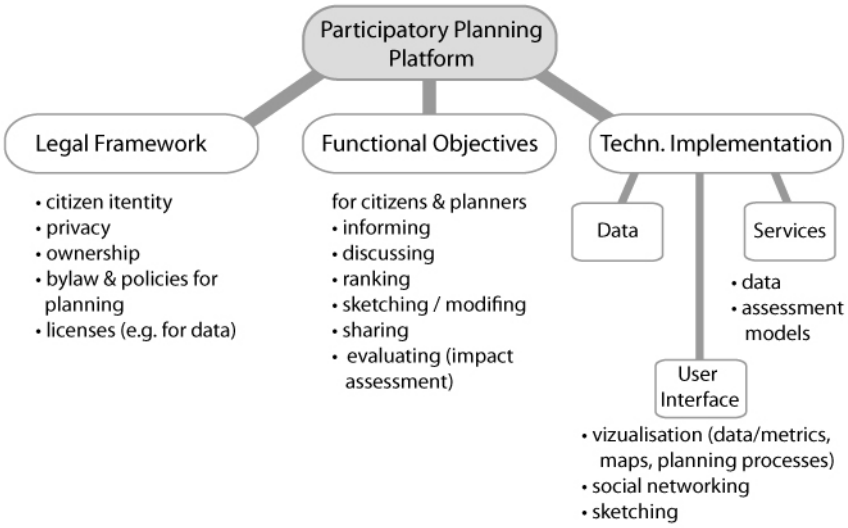

Figure 2. *The proposed framework for a participatory planning platform*

3.1. *Legal framework*

The legal component of the framework contains four aspects that set certain constraints for platform development and its functionality. The first aspect is citizen *identity*. In order to implement an effective discussion and voting platform it is important that a user has only one identity to avoid discussion bias and voter fraud. If people are able to register using several identities, then they can influence votes toward their preferred outcome by increasing their vote share, or they can sway discussions by making it appear that several people have the same preferences (Arango 2009; Mandarano *et al.*, 2010).

A related issue of particular importance to online discussion is *privacy*. If people must participate in discussions using their real name, then they may not express what they really think, or may be less critical than they might otherwise be (Guhathakurta 1999; VeneKlasen 2002). Having an opposing opinion may open the user to unwanted tension within the community (Gutmann *et al.*, 2007), or real-life attack. Additionally, should a contributor wish to remain anonymous, the data custodian is obliged to protect the identity of the contributor (Privacy Act 1980; Personal Information Protection and Electronic Documents Act 2000).

Associated with privacy is the question of *ownership* of information provided, and the right to subsequently make use of the derived knowledge. Good governance demands that contributors provide information willingly; that they are well informed of the possible uses of the data; that they are protected from harm; that they receive benefits arising from their contributions; and that they are not unduly burdened by contributing (Department of Health, Education and Welfare 1979; Firestone 2003; Gutmann *et al.*, 2007). Good governance may also require that certain information collated via the planning platform be protected from widespread dissemination (McCall 2003).

The third aspect of the legal framework covers *bylaws and regulations* that determine when and where citizen participation for planning is sought. There is a long democratic tradition involving citizens in the plan making process (Hodge *et al.*, 2008). The justification commonly cited is that public participation promotes better outcomes (Barton 2002; Passelac-Ross 2011). Community planning in Canada is highly formalized and all provincial and territorial jurisdictions have implemented legislative tools that require that the public be consulted during plan preparation. Whereas municipal councils approve plans in the end, draft plans are generally made available to communities for discussion through public meetings, opinion surveys, Charrettes, etc. These formal, mandated approaches have permitted citizens to be heard, but not necessarily in a comprehensive or continuing way that will ensure their concerns are recognized (Hodge *et al.*, 2008). Many municipalities have implemented new channels of communication in an attempt to move up (Arnstein's 1969) ladder of citizen participation. As has been reported by numerous researchers (Innes 1996, 2004; Craig *et al.*, 2002; Dunn 2007), the more widespread the participation, the better the planning decision. From a community perspective, if a broader range of voices are heard during the design phase of a development proposal, the community's understanding of the planning issues in play will be more comprehensive. As such, the planning system should incorporate these rights held by all citizens through the adoption of a participatory process.

The last component of this section concerns *licenses* for software and data that will be used by the platform. As the PlanYourPlace project has adopted an open source philosophy for software development, we consider data licensing to be of greater concern. Following (Abbot *et al*., 1999), (Chambers 2006) and (Rambaldi *et al.,* 2006), when considering data licences, the participatory platform developers should consider the following questions: Who owns the output? Who owns the maps? Who owns the resulting data? What output will be left with those who created data, i.e. community generated data? Who can analyse the data? Who will use it and for what purpose? Who retains any intellectual property generated? If fees are required for any data, who will pay? These questions make it evident that data licensing and intellectual property issues are many and varied. If they are not considered at the outset, platform deployment will likely encounter difficulties, as experienced by (Carver *et al.,* 2001) when they used Ordnance Survey (GB) data as the base map for their participatory system.

Many national and local governments, including some in Canada, have adopted "open data" principles that enable publicly funded government data to be made freely available to the public. The governments of the United States, the United Kingdom and Australia all made major announcements[1] regarding the launch of open data initiatives in December 2009 (Davies *et al.*, 2010). Some countries, such as Mexico, India, Finland, and New Zealand have had open data systems in place for some time[2].

However, numerous barriers hinder the dissemination of geospatial data in many jurisdictions. The major barriers relate to pricing (van Loenen 2009), digital rights management (Wright 2005; Groenenboom *et al*., 2006), and a plethora of end-user use models (Wright 2005; Vowles 2006; Newbery *et al*., 2008; etc.).

3.2. *Functional objectives*

In the previous section we established some use cases that a platform user should be able to perform. We will list those use cases here again, but in detail: at the simplest participation level, the user/citizen should have access to documents relevant to planning processes or proposals and to urban design concepts (i.e. *informing* oneself). Such documents can include maps, 3D-visualisations, text documents, images, and tables (e.g. statics). However, citizens may also inform the planning authority of what they like and dislike in a community, so that the community and the local planning authority can generate and maintain a synopsis of community desires that can be used when formulating future community plans. It is anticipated that the primary form of communication will be via social networking services akin to Facebook's Wall, where users can leave comments, post documents, photos, or video and audio files (e.g. to illustrate street noise levels), and that the communiqué can be associated with real world objects that can be identified via an online map.

An underlying goal of this work is to create choices for communities with regard to their future development. As such, *discussion* of development options, or planning proposals, to allow communities to come together and reflect collectively on their community's future, and then provide feedback to the planning authority is the next step in participation. Discussions can be related to (a) geographic areas (e.g., a neighbourhood), or (b) a particular object of interest (e.g., an underutilized street intersection or open space), but (c) may also revolve around proposed or existing development plans. Furthermore, (d) commenting on others' observations

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[1] The American project is called the "Open Government Initiative," the United Kingdom's project is called "Smarter Government," and the Australian project is called the "Government 2.0 Taskforce."

[2] Mexico's online system is called the "Portal de Obligaciones de Transparencia" [Transparency Portal], Finland has a public repository of legal and preparatory documents called "HARE", India has a searchable public database of documents for all levels of Government, and New Zealand has launched a full open data portal (Davies *et al.*, 2010).

enables a discussion to take place that might not be possible in more formal settings, where time to consider others ideas is limited. Forms of discussion can include live-chats, email-exchange, and forums (Steins *et al.*, 2009). Open discussion of community development issues may also enable communities to develop alliances with other groups facing similar challenges, such that they can formulate shared values and processes for pursuing, even in the face of strong opposition (Roe 2001; Evans 2002).

Ranking and voting (Pang *et al.*, 2008) on development options and comments by fellow citizens is the next level of participation. Rankings could be performed using a 1-5 scale as used for instance by many online shopping sites (e.g. Amazon.com), or by use of "Like"-buttons found on social networking sites (Boyd *et al.*, 2007) (e.g. Facebook.com).

Following (Tippet *et al.*, 2007) and (Davidson 1998) the rungs of (Arnstein's 1969) ladder of citizen participation can be reconceptualised into five processes: (i) information provision and communication, (ii) engagement in the development of options, (iii) opportunities to respond to options and proposals, (iv) involvement of community in implementation, and (v) implementation of a learning cycle, i.e. what went right, what went wrong, and why. This aligns well with Smyth's ladder of e-participation. We suggest that the PlanYourPlace platform can realistically support processes (i)-(iii) and (v), and therefore deliver a meaningful participation experience for citizens.

In order to address process (ii) and (v) the platform must incorporate design capabilities, i.e. *sketching* of new ideas, and *modification* of existing proposals. Two use cases that will extend the idea of sketching are: (a) *sharing* of plans: i.e. development proposals can be made accessible to planners and other platform users for discussion, and (b) *evaluation* of plans: i.e. descriptive metrics such as cost of services per household, walkability, expected transit use, anticipated household travel, distribution of land uses, etc. can be calculated by the platform — based on a development proposal, or modification to a proposal. This will allow users to inform themselves of the effect of a particular set of design options. However, enabling an evaluation of proposals requires integration of (existing) assessment models into the platform.

3.3. *Technical implementation*

The technical component of the framework lays out what is needed to implement the participatory planning platform given the functional objectives and the legal framework. We identified three main components:

(i) (Geographic) Data — the provision of plans for a particular project as well as the desire for focused citizen feedback suggests that plans, documents, and citizen comments are provided within a spatial context. Therefore it is necessary to have access to general mapping data for user orientation. For example, topographic data, terrain models, public infrastructure such as schools, libraries, police and fire

services, building footprints, land-use data, etc. It is also necessary to have access to a set of geographic data that is useful for understanding local site conditions. For example, transit routes, hydrology pattern, soils, vegetation, local wildlife habitats, climate data, etc. Following (Arendt 1999) there are also a number of derived data sets that are helpful for site analysis (e.g. slope, aspect and viewshed surfaces, prevailing weather and solar radiation, etc.). It is logical that the platform incorporates these datasets through a spatial data infrastructure.

(ii) User Interface — the user interface will allow the user, i.e. the citizen or planer, to perform the actions listed in Section 2. The objective of the PlanYourPlace project is that all user interaction will be performed entirely within a web browser environment. The user interface should offer three groups of functions, outlined below.

(a) Visualisation of documents — documents can be textual descriptions of planning concepts, photos, graphics, metrics derived from evaluation using assessment models, etc. As planning is an inherently spatial process, an interactive map component is important for visualization of development options, and to deliver the spatial context for user comments. Furthermore, tools that visualize the complete planning process, and that show the actual stage and (intermediate) results of the modeling processes may be useful for citizen education.

(b) Social Networking functions (Fletcher 2010) — this group of functions will allow users to post and share documents (plans, sketches, images, etc.), allow users to comment on documents and other remarks, and allow users to link their comments to a location in a map. This georeferencing of local spatial knowledge has proven to have a positive effect on community empowerment and cohesion, and helps communities engage in peer-to-peer dialogue and promote their aspirations and concerns with higher-level authorities (Fox *et al.*, 2005; Chambers 2006; Corbett *et al.*, 2006). Additionally, ranking and voting tools will be provided so that users can express their preferences. We also envision two types of "information walls" that represent reference objects for documents, comments, and votes. One type of wall will be a "development future wall" and the other type will be a "map object wall"; with a map object being for instance a building, an intersection, an area in need of revitalization, a park, etc.

(c) Sketching and Evaluation functions: These functions will allow the user to sketch their own planning ideas and to modify existing development plans and proposals. The tools will enable the user to create buildings, roads, pathways, and parks, etc. and to specify and modify the dimensions of these objects (see for instance van Maren 2011). Tools for removing such objects are important too. A set of modules that enable the evaluation of an areas current built environment, and of new proposals using environmental assessment models, transportation models, etc. is necessary so as to inform the public of the consequences of the existing development conditions and any future development options (Goodchild 2010).

(iii) Services — by "services" we refer to (geospatial) web-services that are used in Spatial Data Infrastructures (SDIs) to deliver data and process/evaluate data (Rajabifard *et al.,* 2001; Crompvoets *et al.*, 2004; Steiniger *et al.,* 2011). The

utilization of a service-based infrastructure is necessary for two reasons: (a) different types of geographic and non-geographic data may be stored in different data repositories for maintenance and security reasons. Storing data in different repositories allows faster access if a large number of users demand data at the same time. (b) Assessment models may not be integrated directly in the platform but accessed via web-services. Service-based access is preferred to avoid the workload that is necessary for porting, integration and adaption of models into the platform. Web services aid integrations as they: are modular (i.e. they perform discrete functions); they can be loosely coupled; they hide implementation from the user; they are technology neutral (i.e. they are universally usable); and they are location transparent (i.e. they are discoverable and identifiable from anywhere that has a network connection) (Papazoglou 2003; Luthria *et al.*, 2009).

4. Technological state of the art

The following subsections review the state of research with respect to the technological side of the platform. The review is structured into two areas: Participatory online-GIS research, and Assessment Models. Based on the review we will be able to make design decisions with respect to the platform architecture, its detailed functionality, and the software we need and can use. Subsequently it enabled us to develop an implementation strategy that will be outlined in the following section.

4.1. *Existing participatory online GIS platforms*

As identified by (Mandarano *et al.*, 2010), the literature evaluating online civic engagement for planning is limited, (Foth 2008) being one of the few additional works found. However, there is more valuable research on internet-based Public Participatory GIS (PPGIS) (see Table 1 and Haklay *et al.*, 2003; Corbett 2009, etc.), and more general in web mapping (Haklay *et al.*, 2008; etc.). In our literature survey of PPGIS platforms we discovered several systems that have already been used in collaborative planning environments, or that can be used for participatory planning approaches, see Table 1. All of these systems have been described and tested with two to three case studies in the research literature (see Table 1 for references). We could not determine if any of these participatory platforms are actively used for ongoing planning activities within a municipality authority. Hence, all of these platforms can be regarded as research prototypes. We evaluated the types of user actions (see Section 2), and subsequently the level of participation, that is supported by the different platforms.

The earliest participatory online platform reported in the literature was Virtual Slaithwaite (Kingston *et al.*, 2000). It was tested in using two case studies: one profiled the village of Slaithwaite, West Yorkshire, to identify positive and negative

issues of living in the village, and the other aimed at finding locations for a new forest plantation (Carver *et al.*, 2001). The platform allowed users to view maps, ask about, and identify map objects, and to add location–based comments. In the site selection scenario for the forest plantation, users could give weights to location factors such as river proximity or proximity to existing woodlands. Based on the weights, a location preference map that ranked all pre-selected locations was generated for each user. The maps were then aggregated to derive a final "population preference." Hence, this first web-based system enabled citizen participation of the first three action levels identified above: information, discussion, and ranking. However, discussion was somewhat limited, i.e. participants could not respond to each other, and ranking was determined by assigning weights to location criteria, whereas other forms of voting, such as single yes/no votes for a location or ranking a location on a 1-5 scale, were not supported.

Web-based PPGIS Platform	Reference	User Actions						Map Component
		informing	discussing	ranking & voting	sketching	evaluation models	Sharing of sketches	
Virtual Slaithwaite	Kingston *et al.*, 2000	●	●	○				GeoTools
Common-GIS & Dito	Voss *et al.,* 2004	●	●	●				Common-GIS
GeoDF	Tang 2006	●	●		○			ArcIMS
ArguMap/ ArgooMap	Rinner *et al.,* 2008	●	●	○				Google Maps
Canela	Bugs *et al.,* 2009	●	●					Google Maps
MapChat	Hall *et al.,* 2010	●	●		○			ka-Map
Virtual Globe	Wu *et al.,* 2010	●	●			○		GeoGlobe

Table 1. *A comparison of existing web-based public participatory GIS platforms that are mostly research prototypes. All systems provide a navigable map interface. Symbols: ● user action is supported, ○ user action is supported partially (see text).*

CommonGIS is a system reported by (Voss *et al.,* 2004) integrating GIS software with an online platform for electronic discourse. It provided map-based information and online discussion capabilities. Ranking and voting functions from the decision support system components of the GIS were also available. Therefore, the first three levels of user actions were covered. Unfortunately, the GIS platform that delivers the mapping functions needs to be on the same server as the

collaborative platform that offers the discussion and polling functions, thereby limiting scalability of the system.

The GeoDF platform was developed by (Tang 2006). It integrated an online discussion forum with an interactive online map. Sketching and annotation tools have been implemented as well (Zhao *et al.,* 2006). Nevertheless, it is important to point out that the idea of the sketching tools was to create geometries for annotation purposes, and not to modify or create new development plans. An interesting analysis tool for users and planners is the "show area of hottest discussion" function that displays a heat map.

ArguMap by (Keβler *et al.*, 2005) presents a first prototype that realizes Rinners concept of argumentation maps (Toulmin 1958; Tweed 1998) as an object-based model for spatially referenced discussions (Rinner 2001; Keβler *et al.*, 2005). ArgooMap later replaced this first prototype, which offers a friendlier user interface based on Google Maps (Rinner *et al.*, 2008). User actions that allow commenting and discussion are possible, but location referenced comments are limited to points. ArguMap and ArgooMap were extended with decision support systems functionality for ranking by (Simao *et al.*, 2009) and (Boroushaki *et al.*, 2010). For site selection case studies citizens were able to weight location factors according to their importance such that a set of possible locations could be ranked. Other ranking functions, e.g. to rank comments, proposals and plans were not realized.

(Bugs *et al.*, 2010) developed a platform for community profiling using Google Maps and tested it with residents from the city of Canela, Brazil. Users were able to post georeferenced comments, categorized as suggestions, complaints, or comments on urban development plans, and vote for and against style. As such, the tool informs through map exploration, and engages the public in discussion of planning in Canela. Therefore, the platform is similar in nature to ArgooMap.

The MapChat system by (Hall *et al.*, 2010) uses free and open source software for its mapping and rendering components. The functionality is similar to that of GeoDF with respect to information provided and discussion tools. MapChat also includes tools for freehand drawing of points, lines, and polygons to which comments can be added. MapChat version 2 is freely available, and MapChat 3 is under development with OpenLayers as the mapping component (see mapchat.ca).

A virtual globe-based system developed by (Wu *et al.*, 2010) focuses on visualization and participation for planning. When compared with the other platforms it offers similar capability for exploration of map objects (informing) and location based discussions. However, unique platform features include (i) 3D visualization (e.g. of buildings), (ii) the ability to compare different architectural designs within their local context, and (iii) the option of night versus day, and solar shadow simulations. These features take the first steps towards the inclusion of evaluation functions in a participatory platform.

From the literature review it is apparent that current online platforms provide information and discussion tools. Functions that enable higher levels of citizen participation for planning, such as ranking and voting methods, sketching, and impact assessment evaluation, are typically not included, or are only partially

implemented. This lack of participatory breadth may be accounted for by the fact that until recently it has been technologically challenging to develop tools for online sketching and impact evaluation. However, online surveys and ranking tools have seen widespread use now. Consequently, the PlanYourPlace project aims at closing this technological gap and the project's research component will need to focus on (i) tools for voting on comments and development proposals - and associated voting evaluation tools, (ii) sketching tools to modify and create new plans, and (iii) tools for the evaluation of current and future plans (i.e. sketches) with various assessment models.

4.2. Assessment models

As stated earlier the participatory planning platform that will be developed by the PlanYourPlace project should include functions for the evaluation of the actual built environment and evaluation of development plans with assessment models. Planning Support Systems (PSS) used by planning professionals often provide options for development scenario evaluation with assessment models (Brail *et al.*, 2001; Geertman *et al.*, 2003; Batty 2007; Vonk *et al*., 2007). A diverse range of assessment models have been developed over time, such as housing market models, models for retail location, travel demand models, demographic models, environmental conservation models, land use models, etc. Integrative models, for example land use-transportation models, exist as well (Harris *et al.*, 1993; Brail *et al.*, 2001; Batty 2007).

However, for the PlanYourPlace platform we will investigate only a particular set of models for inclusion, namely (i) models to forecast transportation mode choice and public transit ridership, (ii) models for energy use calculations, and (iii) space syntax models to evaluate effects of urban design on space and place use. We elaborate on these types of models below.

(i) Models to forecast transportation mode choice and street infrastructure — the potential effectiveness of sustainable communities depends somewhat on how citizens respond to changes in land use and transportation measures (Newman *et al*., 1989). There are a diverse range of transportation assessment models (Wegener 2004), however, the PlanYourPlace project is interested in models that focus on sustainable transportation and evaluate the transportation modal shift from single occupancy vehicles towards public transit, waking or cycling (Ogilvie *et al*., 2004; Vedagiri *et al*., 2009; Hamer 2010). (Diana 2010) suggests that effective implementation of mode switching requires proper education of citizenry in order to reduce the cognitive burden necessary to enable switching to occur. As such the PlanYourPlace transportation model will consist of a hybrid discrete choice model, consisting of a revealed mode choice model — what citizens actually do — and a stated mode switching probability model — what citizen might do given more options — to estimate transit ridership This will enable PlanYourPlace users to evaluate the impacts of alternative transit service designs on travel behaviour.

From a community perspective, attention should be given to the quality of the urban street form as it greatly affects pedestrian and cycling activity in a community.

Street design focuses on street network characteristics, block size, number of intersections per square kilometer, sidewalk coverage, building setbacks, street width, number of pedestrian crossings, traffic calming features, and street trees or other physical features that separate pedestrian-oriented environments from auto-oriented ones (Ewing *et al*., 2010).

(ii) Models to evaluate energy demand — urban domestic energy modeling looks at domestic (or household) energy demand. Most of these models examine either energy use in the home, in buildings in general, or in transportation. A recent review of residential and transport energy models was performed by (Rickwood *et al*., 2008). They observed that few models combine transportation and housing energy modeling, or combine transportation, housing, and embodied energy — the energy needed for construction. Hence, (Rickwood *et al*., 2008) point out that research needs to address the development of combined building and transportation energy-use models. They suggest that these could be built based on existing transportation and housing energy use models.

The PlanYourPlace energy module will model combined domestic energy use, giving an overall picture of a community's energy demand. Emphasis will be placed on user understanding of energy issues in their community, and on the usability of the output. Consequently the focus will be less on a close representation of reality but rather on the provision of comparative figures that show differences between urban designs/planning scenarios. Two recent models that are of interest were reported in (Boydell *et al.*, 2010) and (Ratti *et al*., 2005). (Boydell *et al*., 2010) describe a model that determines energy use and greenhouse gas emissions based on built form and transportation choices. The model is geared toward policy makers — focusing on reporting the important issues rather than on closely depicting reality. This makes it less data-intensive, and requires fewer inputs. The other interesting model, developed by (Ratti *et al*., 2005), isolates the effect of urban form on building energy use. That is, the model calculates differences in energy use of buildings based solely on the built form. It is not predictive or diagnostic, but instead gives comparative figures of energy use with respect to built form.

Presentation of energy use is an important issue for the PlanYourPlace platform since citizens and not (science) experts are the targeted users. An example of energy modeling output understandable for lay users can be found in the popular Ecological Footprint model (Wackernagel *et al.*, 1996). The output tells the user how many Earths would be required to sustain the user's consumption habits if everyone had similar habits. This gives an indication of whether the user's energy demand is within reasonable limits compared to Earth's capacity, and whether the energy use is equitable compared to energy used by others (Newman *et al.*, 2008). Calthorpe's *Urban Footprint* also generates understandable output for the citizen (Calthorpe 2011). The model gives impact figures such as land use, energy demand, and costs. It compares status quo sprawl, compact development, and compact development with energy efficient construction methods and appliances, and renewable energy use. The impacts of these scenarios are compared to each other to help users conceptualize and understand the impacts of different development approaches.

(iii) Space Syntax models and visualization methods to evaluate urban design on space and place use — space syntax theory describes and measures quantitatively the configurational properties of urban space (Hillier *et al.*, 1984). Studies have shown that correlations exist between space syntax measures, such as integration and connectivity, and the use of space. For instance, (a) highly integrated streets create a greater number of pedestrians and car movements (Penn *et al.*, 1998; Read 1999; Raford *et al.*, 2006), (b) overall connectivity of a street network is positively associated with increased pedestrian trips for leisure and increased utilitarian pedestrian trips (i.e., walking to work, or to get groceries) (Baran *et al.*, 2008), and that (c) higher local street connectivity (Boarnet *et al.*, 2001; Frank *et al.*, 2005) and (d) shorter blocks (Moudon *et al.,* 2006) results generally in more walking. Consequently, for the PlanYourPlace project we aim to use such correlations between place use and space syntax metrics to evaluate different planning scenarios, (i.e. different sketches). We will therefore implement metrics similar to (Jiang *et al.*, 2004; Porta *et al*., 2006; and Tomko *et al.*, 2008) in a spatial analysis module. We also plan to develop evaluation models that connect these metrics with results from the literature cited above.

Additionally, we will develop visualization tools designed to aid citizen's understanding of different urban morphologies. For example, users will be able to compare and rank various intersection and "high-street" configurations, ranging from existing status quo development to more intensive pedestrian friendly mixed-use development.

5. The road ahead – platform implementation strategy

Here we summarize our implementation strategy for the PlanYourPlace platform. The implementation of the participatory platform requires several stages that address different functional objectives to enable user actions discussed in section 2. In addition to the implementation strategy, we discuss first the case study that will be used for development of the platform, and outline our evaluation approach to address usability of tools that are developed.

5.1. *Case study — the Middle Ring, Calgary*

To test the participatory and educational utility of the PlanYourPlace platform a number of usability studies that focus on the use cases described in sections 2, 3, and 4.3 will be undertaken within the "middle ring" of the City of Calgary, Alberta, Canada. Calgary's "middle ring" is comprised of approximately 80 neighbourhoods of Calgary's ± 230 that were developed between the 1950s and 1970s. They now form a reasonably consistent band around the inner city grid neighbourhoods, with the exception of the eastern part of the City that has a broad industrial corridor, and the airport interrupting the residential fabric.

Development of these neighbourhoods followed the "Neighbourhood Unit" model developed by (Perry 1929) for New York. The neighbourhood unit was defined as the area that would be served by a typical elementary school. The neighbourhoods consist of a warped grid and crescents block pattern organised around a central school and recreation field(s). In these neighbourhoods, commercial zones were typically assigned to all four corners of one or more intersections of the outside collector roads, and the greatest demand at the time was for services stations. It was common for two and sometimes three corners of one intersection to be developed as service stations. Commercial development within the neighbourhood unit typically took the form of auto-oriented strip malls with a large grocery store anchor and large surface parking lots. These developments were also located at the periphery of the neighbourhoods.

Several issues regarding the Middle Ring neighbourhoods have been identified (Sandalack *et al.*, 2010), and inform the planning direction of the PlanYourPlace project:

- Development of the middle ring was heavily influenced by growth, at the time, of automobile use, which is now in conflict with the City of Calgary's emphasis on sustainability and alternative transportation.
- These neighbourhoods have a changing population with changing needs. However, the neighbourhood form has not proven to be sufficiently resilient to be able to evolve along with those changing needs.
- The auto-oriented commercial developments have not exhibited positive urban qualities and many of the corner service stations are now vacant.
- The homogeneous spatial organization is now contrary to the City of Calgary's aspirations that emphasize a greater mix of uses and finer grain of distribution.
- The form and smaller size of post-war bungalows, as well as increasing maintenance, repair, and land costs, means they do not have the same purchase or resale value in comparison with larger, newer houses in the developing suburbs.
- Neighbourhood densities are not high enough to support a wide range of commercial development, services, or amenities, which results in a low tax-base from which to draw to revitalize the neighbourhoods.

The planning research objectives of the PlanYourPlace project are to develop approximately four topics, based on the issues identified above:

- Investigate methods to increase density that can be acceptable to the neighbourhood residents.
- Investigate processes that facilitate the transition of large single use zones to a blend of mixed use areas, single and multifamily units and green space that more closely reflects the intentions of Calgary's municipal development plan (City of Calgary 2009a) and Plan It Calgary.
- Explore revitalization options of specific land uses to address contemporary needs and objectives, e.g., service station corners, strip malls, etc.

- Building on previous work by (Sandalack *et al.*, 2011), investigate development options for modification of existing townscape types to more intensive urban development.

5.2. *Platform implementation stages*

Here we briefly describe the design and implementation stages that we consider necessary to implement a web-based participatory planning platform. We have itemized a general framework that gives the appearance of a waterfall-like development process (Royce 1970), but recognize that in practise an incremental iterative strategy will be more effective (Martin 2002). Additionally, some activities listed below, i.e. review, and evaluation components, can be run in parallel.

- Definition of platform functionality. The results of this evaluation have been presented in this document.
- Design technical architecture.
- Evaluation and selection of software with respect to basic system infrastructure: data storage (i.e. spatial database management system), interactive web map (rendering and interaction), web-service components, and social networking tools. The PlanYourPlace project team has adopted a free and open source software development framework to ensure later customization and extendibility by others.
- Acquisition of (geographic) base data.
- Implementation of the basic architecture to enable delivery of the user portal (i.e. the mapping component) and services that visualize, process, and analyse data stored on several repositories.
- Functionality Milestone 1: Implementation of functionality that allows fundamental citizen participation, i.e. functions for (i) informing, (ii) discussing and (iii) ranking. Several participatory online GIS exist that provide such functionality (see above). We note that an important aspect of this objective will be the implementation of business rules to ensure that security, privacy and anonymity of users is managed ethically.
- Development of comment and voting evaluation tools for planners.
- Evaluation and selection of suitable general assessment models for development plans. In particular models to evaluate multi-modal transportation metrics, population density, environmental effects, and built form are the focus for the PlanYourPlace project (see section 4.3 above).
- Functionality Milestone 2: Implementation of functionality that allows (iv) evaluation of the current built environment and proposed development plans with assessment models. This step will include integration of the models in the platform infrastructure via web processing services (Schut *et al.*, 2005) and workflow chaining (Wasserman *et al.*, 2007).

- Functionality Milestone 3: Development of tools for (v) sketching to modify existing plans, and to create new plans. Along with the sketching tools, (vi) functionality for sharing the plans will be implemented.

5.3. *Evaluation of the platform*

The participatory platform must be evaluated for its utility, i.e. its support of a particular set of tasks, and for its usability, i.e. the user's experience and opinion of the platform's ease of use (Sidlar *et al.,* 2007, 2009). Evaluation of the platform should be an ongoing process throughout the development. Ideally, after each major development stage that adds a new set of functions to the platform. Several of the existing participatory platforms mentioned in the review have been subject to usability evaluations; in particular (Bugs *et al.*, 2010) tested their prototype with local users; (Kingston *et al.*, 1999) and (Carver *et al.*, 2001) tested Slaithwaite with the citizens of Slaithwaite, ArguMap was evaluated in (Sidlar *et al.*, 2007, 2009) and (Rinner *et al.,* 2009); an evaluation plan for GeoDF was presented by (Zhao *et al.*, 2007); and the MapChat user tests are described in (Hall *et al.*, 2010).

Evaluation of general participatory platforms are described by (Steinmann *et al.*, 2004) and by (Stern *et al.*, 2009). (Steinmann *et al.*, 2004) reviewed 12 participatory platforms with respect to the following 6 criteria: (i) the tools suitability for the task, (ii) data suitability, (iii) user guidance, (iv) understandability / intuitiveness, (v) data description and metadata, and (vi) options for personalization. They note some evidence of "rational ignorance" of users (see also Krek 2005). Economics literature, and in particular public choice theory, describes ignorance as "rational" when the cost of educating oneself about an issue (so as to be able to make an informed decision) outweighs any potential benefit (Caplan 2001).

In general, we can say that usability only becomes an issue when it is lacking or absent. When we ask "*is this platform useable?*" we are really asking "*what level of frustration does a user experience when they endeavour to interact with the platform.*" (Rubin *et al.,* 2008) state that when a product or service (i.e. a web based planning portal) is truly usable "*the user can do what he or she wants to do the way he or she expects to be able to do it, without hindrance, hesitation, or question."* That is, a planning platform as described here should be useful in that it addresses the types of questions that the public, planners, and decision makers may have. It should be efficient, effective, and satisfying in that it answers users' questions with as little effort as possible on the part of the user. Furthermore, the platform should be learnable and accessible, i.e. the portal interface should intuitively direct the user through the enquiry process.

The evaluation by (Stern *et al.,* 2009) does not compare and evaluate different online platforms but rather tries to answer the question of whether or not web-based public participation methods can replace the traditional public engagement approach. Based on observed changes in measures used to identify involvement, trust, and empowerment, between web-based and traditional methods they

concluded that web-based methods can only complement the traditional approach to participation. However, as a criticism of their experiment we note that the web based participation platform used in their experiments was not described – and hence, it is difficult to "transfer" their conclusions to other participatory platforms. However, their paper also highlights that distinctly different age and occupational groups of citizens participated in the web based and the traditional methods. This may be seen as an indicator for the need for both participatory approaches.

6. Summary

This paper presents a framework for the development of a participatory planning platform by the PlanYourPlace project. We discussed in detail the components of that framework, in particular: legal aspects, functional objectives, and technical implementation. The discussion of legal aspects for such projects has rarely been done. To ground the technical implementation we reviewed literature on existing online participatory GIS platforms and assessment models with respect to the project objectives. The comparison of results from our functional needs analysis (from a citizen-centred perspective), with the results of our analysis of existing online participatory GIS highlights a lack of tools that allow higher levels of public participation, such as voting, sketching, sharing and assessment via model evaluation tools. Finally, outlining our implementation strategy should help to put participatory planning platforms into planning practice sooner.

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