Chapter 7
Tools for Citizen Engagement in Urban Planning

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Abstract Engaging citizens in urban planning has the potential to generate effective ideas to reinvent our cities. Particularly, designing easy to grasp and effective tools for co-creating meaningful urban spaces remains a significant challenge and an emerging need. Such tools that can involve the community in an intelligent manner are in strong demand. It is, however, required to design, develop, and implement well-executed engagement tools that open the horizons of evaluating and responding to urban-related problems while involving city councils, architects, ICT developers, and urban planners. In this chapter, a framework aiming to investigate future forms of citizen involvement within urban planning activities is prefigured. It addresses the research aim to present and discuss technology-driven civic engagement in the planning process via a toolset and the outcomes of a market study for this tool. Furthermore, it identifies and discusses the gaps between four main existing groups of urban planning software; physical planning tools, physical/civic engagement tools, civic scenario planner tools, and data analysis methods and how to bridge these gaps. In addition to these, it highlights the potential of such urban planning participatory tools to generate possible socioeconomic impacts and concludes by assessing (1) the degree to which the technology creates an inclusive environment to exchange and implement urban planning related ideas and (2) the extent to which such tools could lead to an integrated and coherent engaging method for citizen engagement.

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Participation in Urban Planning

The word "participation" gained popularity and attention during the late 1960s (Pateman 1976). Participation was not only popular in the political context; it also gained a wide importance in the design of products. "Community design" involves different aspects of collective activities such as "community planning and architecture, social architecture, and community participation" (Sanoff 2000; Toker 2007; Sanders and Stappers 2008). This approach has emerged from the fact that the mismanagement of the physical environment is a major factor contributing to social ills (Barcellini et al. 2015). In participatory design, the roles of different stakeholders and profiles involved in the design are different. The end-users who play a passive role in the conventional and traditional design process are given the opportunity to express their preferences, share knowledge and feedback, and, therefore, play an important role in concept development (Sanders and Stappers 2008).

In Participatory Design (PD), the process is responsive, which means that the designers collect and consider the end-user's feedback related to their design output, but the end-users are not fully empowered or in control of this process (Cimerman 2000). However, the concepts and methods of PD and co-creation vary widely among different studies in social science and according to the field of application (politics, design, etc.). Since the beginning of 1960s, a variety of methods has been established to improve the participation of both end-users and stakeholders in the design process to bridge between the needs and the output (Abras et al. 2004). Various research and books have stressed the necessity of engaging end-users and other relevant stakeholders in the design of their designed and built environment (Horelli n.d.; Kanji and Greenwood 2001; Butler et al. 2007).

In the following section, we explore the different waves of participation in urban planning in the western countries' context during the last 50 years. The extended waves of participation are based on different research (Arnstein 1969; Kelly 2001; Claridge 2004; Miessen 2017a; Meeus and Pak 2018).

1968–1990s Emergence of Participation

In the early 1960s, the role of communities in the built environment gained a considerable importance with some architects and urban planners. In Great Britain, the idea that the public should participate was first raised in the early 1960s with the British architect John Turner. His ideas were developed through a number of articles and publications where he was putting emphasis on the role of households in the architectural design process (Turner 1963). Turner developed an influence approach related to the self-help housing and role of the community in the design process. John Habraken was another writer and Dutch architect who developed his ideas about participation and the role of the user in the design process in the early 60s. His idea for a flexible design approach to housing was published in a book so-called Supports and demonstrated in practice in the mid-1960s. A different component in the community engagement in the built environment was related to the planning approach in the urban spaces (Davidoff 1965). This approach was based on Community Design Centers assisting citizens on a number of issues related to architecture and urban planning. Sherry Arnstein, based on the experimentations of this approach, has created a ladder of participation which is still used as reference for community participation nowadays (Arnstein 1969).

In the 1970s, the Scandinavian countries started to research the role of the user in the design process and the development of projects. The "collective resource approach" idea developed new innovative strategies for workers to influence the design and the use of new technologies in the workplace. It attempted to empower "trade unions and workers at the local level" (Kraft and Bansler 1994).

In the 1980s, there was a new wave to change and find alternatives to the top-down design approaches. Several activities, particularly driven by non-governmental organizations, were leading the change to a bottom-up approach (Kelly 2001; Claridge 2004). The 1980s witnessed as well flourishing of activities, particularly among non-government organizations (NGOs) in seeking alternatives to top-down outsider-driven development. The emphasis was on participatory appraisal and analysis in rural communities. In the 1990s, the participation approach continued to be an important element in the design process, and it became synonymous with sustainable development.

Early 2000s Emergence of e-Participation and Crowdsourcing

In the recent two decades, the use of information and communication technology (ICT)-based participation tools and methodologies for urban planning has gained traction. In order to provide urban stakeholders with platforms for involvement, many technology-enabled participatory tools, approaches, and applications have been developed (Gün et al. 2019). Today, the employment of ICT-based participation platforms for addressing urban issues is gaining traction as governmental authorities consider innovative ways to provide novel, open, and democratic communication channels.

To start with, the e-participation era is an important period in the short history of this field, which emerged in the 2000s. E-participation involves ICTs to engage non-designer groups with diverse backgrounds, expertise, ambitions, and positions in diverse collaborative design activities throughout the design process (Sanders et al. 2010). This method enables non-expert end-users and lay-persons who are not traditionally involved in urban planning, research, and design to participate in design processes. ICT-based engagement platforms, in this sense, are digital arenas for retrieving, analyzing, visualizing, and sharing information, expertise, and alternatives that serve to social causes and policy challenges (Desouza and Bhagwatwar 2014). Particularly, 3D modelling software and games offer new opportunities for civic engagement in urban planning. These complex and interactive software solutions allow spatial configurations and data to be visualized, accessed, and interacted with representation formats convenient for novice participants without any planning or spatial design expertise.

Among the ICT-enabled participation paradigms, crowdsourcing is a recent approach emerged in the 2010s which dominated the field in the last decade. According to Saxton et al. (2013), crowdsourcing refers to a certain form of outsourcing tasks to a specific mass of users: it is a sourcing model where organizations use Internet technologies to track and employ the efforts of a virtual crowd to carry out designated tasks. By using online platforms to harvest the *wisdom of the crowd* and make use of the collective intelligence of multitudes of users, crowdsourcing opens up a whole slew of possibilities for urban planning and government and nonprofit applications (Brabham 2010).

Since the emergence of crowdsourcing as a dominant ICT-enabled participation paradigm in the 2010s, starting with the English-speaking countries, a variety of platforms have been put in action to address urban issues in different parts of the world. Among those, the frequently referenced platforms were *FixmyStreet, OpenPlans, CitySourced, and Neighborland*. The empowerment capacity of these crowdsourcing platforms are found to be quite limited since these enable limited information exchange and idea sharing, located in the lower rungs of the ladder of citizen participation (Pak and Verbeke 2013). From the perspective of bottom-up spatial design and planning, these platforms lack the necessary tools and capabilities to enable a wide range of stakeholders to co-create urban plans or designs since they mainly aim at collecting feedback from the users (Pak and Verbeke 2013).

An in-depth study of 25 crowdsourcing platforms in Europe, chosen from a total of 106 platforms (Gun et al. 2020), showed that the vast majority (77%) of the platforms strive for one-sided information sharing, the lowest degree of empowerment on the participation scale introduced by Senbel and Church (2011). Hardly 12% of systems, including Maptionnaire, MinStad, and Smarticipate, aimed to allow end-users to build their own goals and ideas. According to this study, *BetriReykjavik, BlockByBlock, FindingPlaces, Quakit, ZO!City,* and *Unlimited Cities* were among the few cases that allowed users to engage in the co-creation of urban plans and ideas.

The limitations and challenges of the use of crowdsourcing platforms in urban contexts have been covered in several studies focusing on real-world cases, and these were not only restricted to lower levels of design empowerment. Two early analytic studies found that crowdsourcing platforms mainly benefited people with a greater level of education and wealth (Helsper 2008). Later research revealed that crowdsourcing platforms can be influenced by existing social and spatial inequalities such as the digital divide, the inability of disadvantaged citizens to access the Internet to utilize platforms, lack of skills such as map and plan interpretation required to use platforms effectively, and variations across interest groups in terms of age, social position, expectations, ethnicity, and economic level (Evans-Cowley and Hollander 2010; Desouza and Bhagwatwar 2014; Vicente and Novo 2014; Pak et al. 2017).

The overrepresentation of the privileged parts of the (Western) society on crowdsourcing platforms is prominent and a major problem according to Bryson et al. (2013, p. 29). These particular users can be profiled as male, middle-aged, political *techies*, and sensitive to urban and neighborhood issues. Overrepresentation can potentially happen when exclusive groups produce more content, reports, ideas, and feedback, echoing the well-document exclusion issues in face-to-face civic planning practices; however, in crowdsourcing, this can happen on a far larger scale (Bryson et al. 2013).

These findings imply that crowdsourcing might increase inequality in terms of both representation and cause unjust socio-spatial effects (Pak et al. 2017). When used uncarefully, crowdsourcing techniques may unavoidably exacerbate socio-spatial inequality in our cities. Therefore, it is of utmost importance for crowdsourcing practices to make sure the concerns of disadvantaged groups (digital illiteracy, language hurdles, and immigrant origins) are representatively addressed. Communities where the majority of the population is immigrants and undereducated, for example, are unable to adequately report concerns in their neighborhoods, putting them at danger of degradation, whereas well-educated high-income citizens profit from the crowdsourcing platform. This can lead to large socio-spatial disparities over time which serves against the democratic and egalitarian principles behind participatory planning (Pak et al. 2017).

2010s Emergence of Critical Spatial Practice as an Alternative to Participation

In a critique on Jane Rendell's approach (Gallo and Pellitteri 2018) to critical spatial practice limiting it to the expansion of the spatial to the artistic frontier, Miessen argues for the staging of a reorganized relationship, combining a re-thinking of existing disciplines with the production of a new body of recognizable work (Miessen 2017b). Critical spatial design aims to go beyond architecture as a physical construction and explore the construction of alternate realities, criticizing existing protocols, and generating new protocols for this venture "reflective practicum in designing" (Schön 1987). In parallel to this line of thought, Awan, Tatjana Schneider, and Jeremy Till (Awan et al. 2013) describe their three major criticisms toward the notion of "architectural." The first argument condemns the architectural obsession with buildings and objects as its primary location. An object-oriented and a temporal regard to architecture neglects the occupation of the building, its temporality, and the relation to society and nature. This resonates with Manzini's (2015) argument that design – in general – needs to be redefined as he notices a shift away from the tangible object toward services, experience design, and organizational structure.

Breaking free from prevailing modes of urban-architectural design requires the establishment of a working practice exploiting the productive encounters between different disciplines (De Smet et al. 2019). While being about a network, our critical spatial practice represents itself as a networked practice.

This involves developing the participants' capacity of reflecting-in-action and reflecting-on-action as a crossbencher and going off autopilot actions; in other words, instead of blindly following and repeating what is learned in the past, questioning the existing protocols within the field of architecture with the will to develop new critical practices is set-forth. The "crossbench practitioner" (Miessen 2017b) is describing "a participator who is not limited by existing protocols, and who enters the arena with the will to generate change." This requires participants to get out of the comfortable boundaries of traditional expertise in architecture, toward the unknown, the intentional and skillful mastering of incompetence in the ocean of practices. Critical spatial practice in this context is a form of participatory action research. The participants combine their role of agent of change with one of researcher and therefore commit themselves to reflexivity, paying attention to the process of action and reflection as they unfold.

Critical spatial practice provides a testing ground for phenomena, methods, and tools as elements of a transdisciplinary framework. This is also the staging of a reorganized relationship, combining a re-thinking of existing disciplines with the production of a new body of recognizable work. At the same time, research and design consortiums have developed similar characteristics: new emerging alliances, defining new partnerships, focusing on new ways of transdisciplinary thinking and setting up new kinds of joint professional or academic projects.

Benefits and Importance of Participation in Urban Planning

Community design engagement is about involving the citizens and the civic organizations in the design of a project. It does not only consist of sharing information and telling people what is done and what is decided, but it has to be a two-way information sharing (activity, task, process). In general, this process is about gathering citizens' and civic organizations' preferences, viewpoints on what needs to be achieved, priorities, and significance and including them in the design process.

The importance of participation in the design process has been the subject of different research studies and is well established in the literature. Al-Kodmany (1999) recognized different benefits from participation, stating that participation gives a stronger sense of commitment and increases the users' satisfaction regarding the design solution, by providing realistic expectations of outcomes (Al-Kodmany 1999).

Additional viewpoints enlarge the choices of possible design solution spaces and improve the value of the ultimate decision (Kelly and Van Vlaenderen 1995; Kelly 2001). The more opinions collected during the process of design and while planning, the more probable the end product will address the concerns of the community

(Bamberger 1991). Sharing additional viewpoints and ideas leads to better facilitation of actions and activities with a higher potential for generating ecological and sustainable solutions (Price and Mylius 1991).

Experts and decision-makers recognize that the community, using the designed and planned spaces, has a close link with this space, while they do not often have this relationship with the planned spaces. This close relationship provides knowledge that should be considered leading to a better decision.

Participation is recognized to encourage the sense of responsibility and concern to solve the issues and problems in planning (White 1981). It also ensures that the requirements and needs of the community are being considered.

Limitation and Issues of Participation

The limitations and issues of community participation in the design process has been also a subject of different research, and different authors criticized it. These limitations and issues must be considered whenever a design process project is to be implemented with a participatory approach. Obstacles that can be encountered with the participation may include: being time consuming, increasing the financial costs, no guarantee of successful result, professional superiority, uncertainty about the results of public involvement, lack of transparency, empowering specific participants, and the mistrust between the communities and experts (Cleaver 1999; Sanoff 2000; Miessen 2017b; Mubita et al. 2017).

Many researchers claimed that community participation tends to be a time-consuming process (Towers 1995; Irvin and Stansbury 2004). In the latest cited reference, the authors have recognized that in some circumstances, the community participation can be time-consuming and may be costly and ineffective (Irvin and Stansbury 2004). According to them, the community participation in the design process is more expensive than if done by a single expert. The implication of community in the design of a program became a frequent process and is now rarely questioned. However, Cleaver (Cleaver 1999) claimed that participation does not always lead to the requested solutions or result. Therefore, according to his research, there is no guarantee that the requested criteria of the community are considered in the final solution.

Urban Planning Through Different Design Processes

Urban planning is defined in theory as a space focusing on physical geometries, association, and organization of different urban functions with the purpose to shape human activity (Carmona 2010). Urban planning addresses the development, design, exploitation, and use of land spaces for human activities purposes. It is also related to social aspects with a purpose to improve human life at the social, cultural, and environmental levels (Sandercock 1997). As a terminology, the "Urban Structure" refers to the "pattern" or "arrangement" of the urban spaces considering streets, blocks, buildings, landscape, and open spaces (Llewelyn and David 2007). Mougthin defines urban planning as "the method by which man creates a built environment that fulfils his aspirations and represents his values" (Moughtin et al. 2003). He also claims that the city is an "element of people's spiritual and physical culture" and the "central to the study of urban design is man, his values and aspirations."

The process used to build and conceive urban environments has an importance in providing viable and maintainable communities (Katz et al. 1994) and ensuring that the goals of the urban structure are satisfied. Multiple studies have discussed the design processes and action stages of urban design practices. Again, Moughtin et al. (2003) agreed that following a critical evaluation of alternative solutions, the decision-making processes in urban planning are not linear; according to him, they represent a progression loop between the multiple stages; therefore, they can be called iterative processes (Moughtin et al. 2003).

Different approaches for urban planning were proposed as well (Roberts and Greed 2001; Moughtin et al. 2003; Boyko et al. 2005; Dias et al. 2014; Carmona 2015) focusing on the idea that urban planning is a sequential series of connected decisions. Each sequence has a description of actions and detailed level of decisions. This sequence is detailed as "analysis, synthesis, appraisal, and decision." The decision level is repeated for each design stage in this sequential series (Moughtin et al. 2003). Roberts and Greed (Roberts and Greed 2001) defined the urban planning process in four sequences; the process starts by defining and analyzing the problem; it continues by conducting surveys and different analysis activities. Following these analyses, the planning team develops opportunities and ideas. In the later stage, strategies and options are assessed for the decision-making process.

After this review of urban planning traditional process, we can conclude that the main components and interventions in a traditional urban planning process are related to: (1) collection of needed information; (2) general study, identification of problems, and investigation of possible solutions; (3) development of solutions; and (4) decision-making and communication (Fig. 7.1).

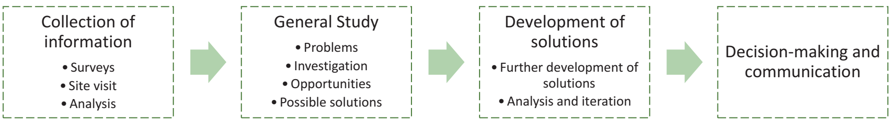


Fig. 7.1 Urban planning main design components

The Emergence of Computational Techniques in the Urban Planning Processes

Modern planning practices and theories encourage methods involving different actors in the urban planning process. The different stakeholders usually have a variety of objectives, values, and aims to accomplish (Mosadeghi et al. 2015). The applications to quantify the objectives of the stakeholders have increased with different approaches based on computational procedures and techniques that allow handling varied data and inputs. In this direction, computer-based applications applied to urban planning started to emerge in the daily practice of professionals. In particular, a high increase in computer-aided parametric design applications handling urban planning can be noticed.

Parametric Design Modelling

Parametric design modelling was used, in several studies, as both a "generative tool" and a "control function" enbaling the creation of flexible geometries based on a set of input parameters defined in algorithmic formulas (Schumacher 2008; Daniel et al. 2011).

In these applications, many research groups suggested a parametric model to establish the plots and the building shapes with consideration to parameters related to density, proportion, and alignment. As for the control function, the design was assessed in relation to environmental features such as light, noise, wind, etc. With such approaches, the designers have a possibility to modify the urban structure and pattern, preserving the relationships between the different geometrical components and controlling the assessment of desired features.

Research coupling urban design with parametric design methods increased during the past 20 years. These are including different techniques for optimizations and generations of urban spaces with different simulations and iterations. The research reported below arised from a search conducted in Google Scholar with keywords related to the association of parametric/urban planning and generative design/urban planning.

These applications deploy different technologies and methods to generate and produce urban spaces and urban structure patterns. They are based on powerful parametric and simulation capabilities or also on artificial intelligence capabilities to help designers in their urban design process.

In this context, computer-aided parametric tools provide a flexible and smart framework for the generation of urban composition. The generation of urban blocks is driven by associative and parametric approaches. These studies showed that there is a potential in applying computer-aided parametric design tools to the urban planning application. Some of the studies also showed a potential to implement a participatory approach. It should be mentioned that these applications were in most cases based on presenting parametric applications as (Dongyoun et al. 2011; Steiniger et al. 2016; Schubert et al. 2017; Chowdhury and Schnabel 2018):

1. A communication tool to inform the end-users about the design solutions
2. A controlling tool to control performance simulation of the solutions proposed
3. A generative tool to allow the generation of urban blocks based on different input
4. A tool or a methodology to capture the end-users' preferences as input parameters capable of influencing the design outcomes in few applications

The use of computer-aided parametric tools allowing a simulation and optimization of design solutions enables a performance-driven design process. Important aspects in the participation through a performance-driven design process are the following:

1. The need to have a clear and understandable interface as a common base for discussion and participation
2. The need to identify the design stages where participation of end-users will make sense and will be beneficial
3. The need to identify the methods and means of participation in the design process

Urban planning applications developed with computer-based parametric design tools, as already shown previously, are emerging in the practice of architects and urban planners (Cockey 1955; Schumacher 2008; Da Silva and Morim 2010; Saleh and Al-Hagla 2012; Muther and Halles 2015; Wang et al. 2015; Sabri et al. 2019). These applications are evolving and changing to answer different challenges related to urban planning. The functions of these applications vary from sharing information on the selected environment to discussions between end-users and other concerned stakeholders. The modalities of participation in urban planning remain complex to implement in the design process from different points of view, such as the time and cost. In the following sections, we explore these problems and identify ways to answer these issues.

Toward Digital Twins of Cities

Among the latest computational trends, digital twins are gaining a strong interest. The paradigm enables the coupling of the smart cities approach to 3D urban visualizations and is being developed to tackle urban planning, urban management, the implementation of smart systems, and several other applications ranging from technological deployment in cities to the co-creation of citizen-centric services. Among a wide number of initiatives, some of those digital twins are already in the first stages of their actual operation, such as in Helsinki (Finland) (Ruohomaki et al. 2018), Barcelona (Spain), Amsterdam (Netherlands), and others. Interestingly, such initiatives rely either on public, private, or both investment models and provide a wide range of data and applications, ranging from access to cities' open datasets to high level of consultation with citizens. These cutting-edge technologies develop rapidly and serve the purposes of cities development, while encompassing various goals including sustainability and carbon neutrality, well-being, and health as well as inclusiveness or equity.

Geodesign

The geodesign approach provides a multidisciplinary design framework and set of tools for exploring issues with a multi- and transdisciplinary view (Steinitz 2012). It consists of resolving the conflicts between the diverse points of views. This approach can be applied to different design planning processes and in particular in the urban planning application where it can be considered as a powerful tool to support the decision-making process when dealing with conflicts and issues. Carl Steinitz's geodesign framework uses a series of questions which guide the different participants of different discipline through the process of design (Fig. 7.2).

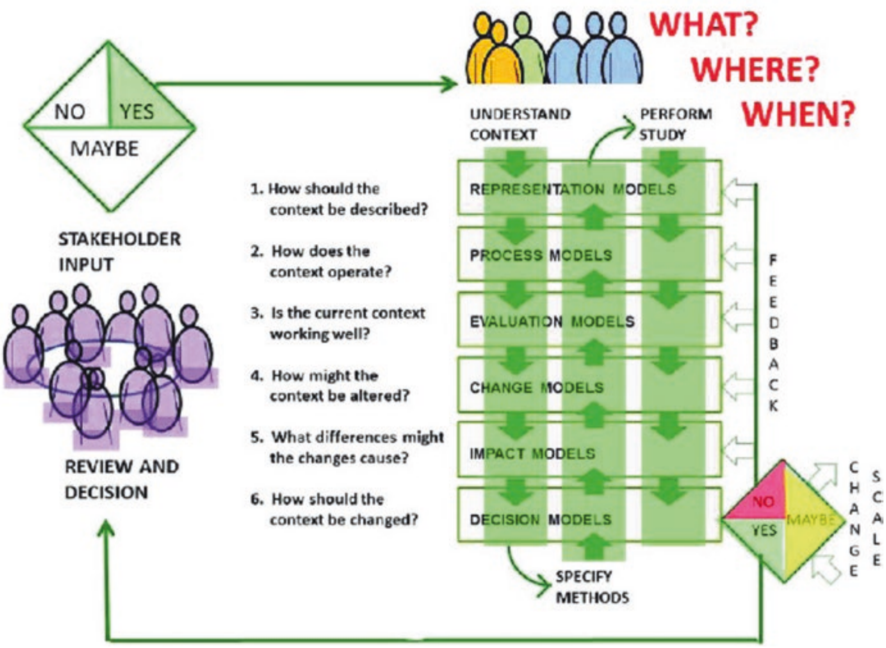


Fig. 7.2 The series of questions to guide the participants through the process of geodesign. Courtesy Carl Steinitz (Steinitz 2012)

Key Indicators of Urban Planning Performance Enabled by the Computational Techniques

Those above-mentioned goals significantly adressed through urban planning projects as well as through the management and operation of urban areas require the capability to assess and benchmark the decisions made.

A variety of initiatives address this requirement, from various perspectives:

(a) The planning of urban districts requires engineering-driven simulations to evaluate energy and water consumption, wind, solar gains, or even comfort.
(b) The development of smart cities' technology needs a careful monitoring of citizens' acceptance.
(c) Overall, the environmental impacts of territorial development and policies claim for high-level models.

This section presents some initiatives that set the scene in terms of criteria covered in the design framework. In order to insure the well-being and comfort for the inhabitants, it is important to allow them to choose and prioritize their needs in terms of performance. When the inhabitants are inputing their needs and objectives, these needs have non-physical characteristics, which mean that the inhabitants are more concerned by the performance of the urban space rather than by its physical and geometrical properties. However, these objectives are driven as well by physical parameters of the built environments that define its environmental assessments.

Environmental Evaluation of Urban Planning Projects

Urban planners are facing a growing demand for high performance projects in terms of control and reduction of environmental impacts. The environmental assessment evaluation in urban planning is time-consuming and usually based on ratios, as actual detailed values are lacking. Different variables and parameters need to be considered (e.g., land use, density, socioeconomic level, accessibility, transport, air quality, water quality, noise level, sunlight, radiation, shadow. Etc.). Many tools, shown later in this chapter, allow the experts and urban planners to handle the complexity of the data to enable producing alternative solutions with a higher environmental performance. Environmental evaluation of urban planning is now possible to conduct easily with the latest technologies and tools (sensing technologies, GIS, simulation tools, etc.). This helps in producing more accurate environmental evaluation in complex urban planning situations and in consequence to produce better urban cities.

Resiliency and Environmental Impacts Evaluation of Cities and Territories

Comprehensive frameworks appeared in the last decade to support decision-making in relation with cities' development. The EU Reference Framework for Sustainable Cities provides a set of 5 dimensions and 30 objectives "promoting a European vision of tomorrow's cities."[1] It enables policy makers, professionals, and citizens in monitoring project development while crossing several dimensions, including spatial, governance, social, economic, and environment.

Besides pure urban planning, a strong focus is put on the ability to monitor, analyze, and react to adverse event affecting urban systems. According to the Resilient Cities Network,[2] "urban resilience [is] the capacity of a city's systems, businesses, institutions, communities, and individuals to survive, adapt, and grow, no matter what chronic stresses and acute shocks they experience." Among others, the City Resilience Framework[3] is a "unique framework developed by Arup with support from the Rockefeller Foundation, based on extensive research in cities. It provides a lens to understand the complexity of cities and the drivers that contribute to their resilience."

Also, the so-called Doughnut economics principles, defined by Kate Raworth (Raworth 2010), propose a doughnut-shaped visual framework [illustrating] a safe space between "planetary boundaries" and "social boundaries" in which "humanity can thrive." Interestingly, this model enables applications beyond the scope of urban planning and even cities' managements, providing the capability to upscale the approaches at territory or even national levels, encompassing a variety of goals (Fig. 7.3).

Participation-Based Design Process Framework

To answer the gap between the actual applications used for urban design and the participation of end-users in the design process, the authors propose a conceptual framework reflecting the main steps of urban planning process and associated methods to engage the community in the process. The developed design process covers the different design stages of a traditional urban planning process and includes various levels of participation of the community/citizen/end-users and different stakeholders. The parametric capabilities integrated in the developed design process enable nonlinear interactions, loops, and modifications which help in creating more iterations and exploring more possibilities.

The framework is composed of three interactions covering different design stages of urban planning traditional process. This framework is supported by

[1] http://rfsc.eu/european-framework/

[2] https://resilientcitiesnetwork.org/what-is-resilience/

[3] https://www.rockefellerfoundation.org/report/city-resilience-framework/

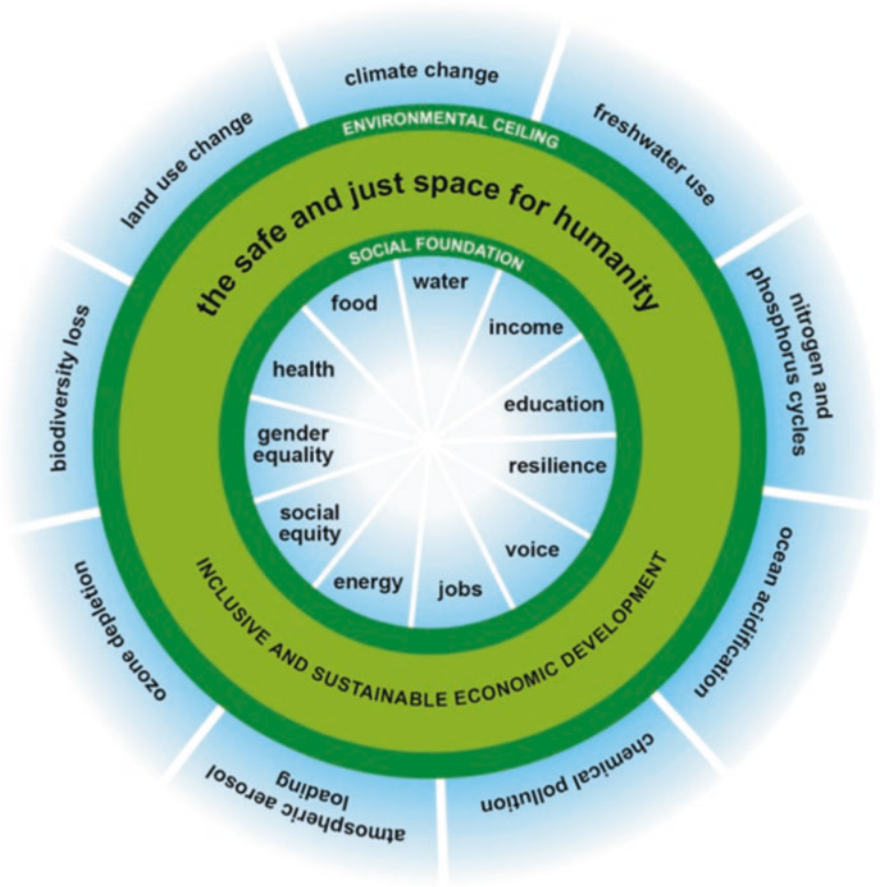
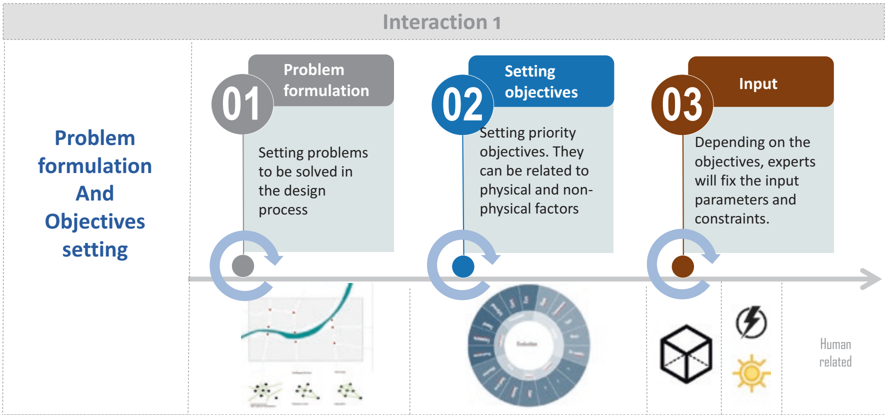


Fig. 7.3 Doughnut model. (Source: Oxfam; Sayers and Trebeck 2015)

different devices and tools which are associated with various levels of participation. This conceptual framework is characterized by recommendations of the visualization to enable a better understanding of the design project.

First Interaction: Problem Formulation and Objectives Setting

This interaction covers the stages of the urban planning where the objectives including the physical and non-physical criterions are set. In this interaction, the rank of the criteria is defined including distinctive features in terms of priorities and needs with the citizens. The criteria needed to explore the suitability of the selected land are defined to help in the site's actual conditions' identification based on previous studies and comprehension of the constraints. These studies and analysis should be



Type of possible participation	Delegation, Consulation	Delegation, Consulation	No participation in this step
Format of information	Graphical and numerical	Graphical participative interface	Modelling interfaces
Mean of participation	Tangible table, Projection screen	Tangible table, Projection screen,	-
Participants	Representors, Users (surveys)	Representors, Users (surveys)	-

Fig. 7.4 First interaction of the framework

based on collected data related to the site or simulations based on different simulation tools. The ranking of objectives can be obtained by conducting different surveys or by a direct participation of participants in the design process (Fig. 7.4).

At the end of this interaction, a decision-making process should be conducted to pass to next steps of the framework. The steps of this interaction are the following.

Step 1: Selecting the Site, Establishing the Current, and Actual Conditions of the Site

This step consists of the selection and identification of the potential of a selected site. It considers the selection of the site and the gathering of related information which can be performed based on the actual data gathered or different simulations using computer-aided parametric design tools.

Step 2: Defining Land Constraints and Establishing Criteria for the Suitability of the Land Use

In this step, experts can perform the analysis of the site according to distinctive features and criteria (noise simulation, daylight simulation, proximity, mobility simulation, etc.). This will help in creating a diagnostic of the actual conditions of the site which will be considered in the generation of the different alternatives.

Step 3: Setting and Ranking Objectives and Values

Setting priority objectives with end-users, inhabitants, and experts is conducted in this step of the first interaction. Objectives should be adapted to the local needs and grounded to each situation. They can be related to energy, well-being, mobility and other performance indicators, proximity, and area needed. Citizens and end-users can also translate the objectives with different weights of importance according to their evaluation and preferences. In this step, citizens can rank the objectives based on their preferences. Ranking the objectives can also be done by surveys (indirect participation).

Second Interaction: Dependencies and Requirements Generation

This interaction corresponds to the exploration of the suitability use for the selected site. Indeed suitability analysis is a logic methodology to analyze the score of fitting features. In our case, the suitability analysis is performed to define the relation between the urban functions to distribute in the site and the features of the site based on fuzzy logic. The end-users can explore in this step, the site criteria and suitability use. A methodology is defined based on algorithmic formulas where the end-users will be exploring the suitability impact of the requirements. After the exploration, and since urban planning is typically concerned with assembling, organizing, and locating activities and land-use in the space, the end-users can explore the organigram of the different functions and the suitability of the organizations. The steps in this interaction are the following (Fig. 7.5).

Step 4: Site Criteria Diagnostic Communication

This step will focus on the requirements of the program function for the site. We invite in this step the end-users and delegation to discover the diagnostic of the site according to the criteria that have been set previously. The main objective of this step is to communicate the results of these criteria to make the analysis more understandable to the end-users. End-users can discover the diagnostic related to the criteria such as the daylight, the proximity of some crucial point, distance from noise, and distance from pollution sources.

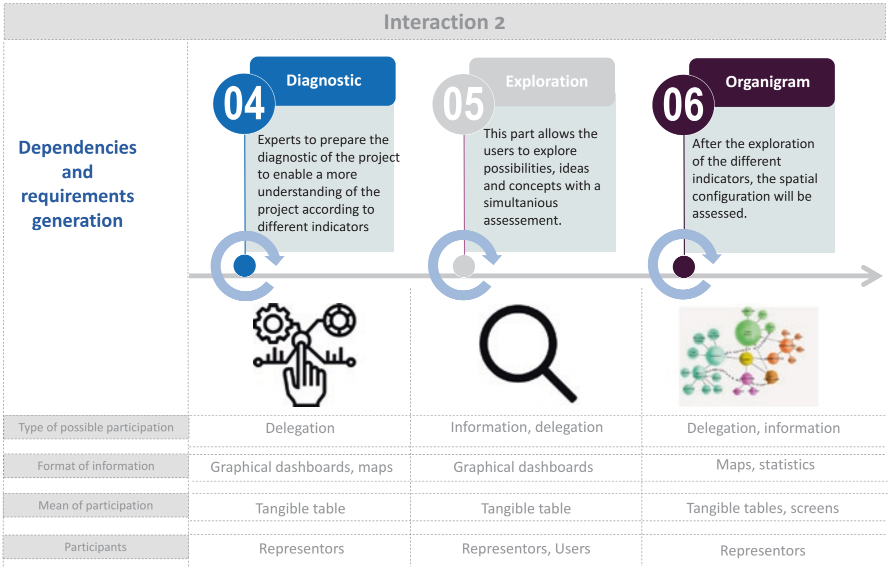


Fig. 7.5 Second interaction of the framework

Step 5: Site Exploration and Recommendation of Suitability Land Use

After the diagnosis of the site, and since we mentioned previously that we encourage a better communication and exploration process for urban planning rather than an optimized process, this part focuses on the exploration of the suitable land use according to the criteria. The main objective is to communicate and exchange between the different participants. The system will be generating recommendations and percentage of fulfilment of each land use in the selected site.

Step 6: Site Allocation and Recommendation of Fulfilment for Functions

This part will identify the organigram and distribution of the suitable land use in the selected site. Recommendations will also be made by the system to ensure that the criteria needed as required by the end-users are still respected. Participation of the citizens is particularly important in this stage and will be enabled through multiple devices, tools, and surveys.

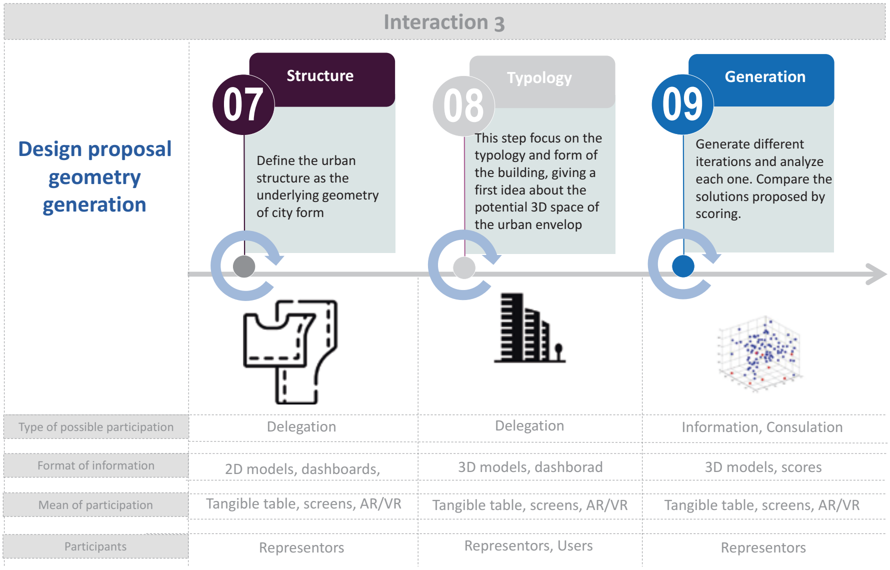


Fig. 7.6 Third interaction of the framework

Third Interaction

This interaction is related to the generation of the urban pattern and buildings' 3D geometry typology. An optimization of the building typology is addressed in this interaction in order to experiment different solutions and alternatives. This interaction enables end-users to explore different types of urban patterns and urban 3D geometry generation. The steps in this interaction are here reported in Fig. 7.6.

Step 7: Urban Structure Pattern

Urban structure is the underlying geometry of city form. This step defines the use pattern in the designing of the street networks and layouts. The professionals based on the input set in the two first interactions define this entry. Recommendations are based on cultural and other predefined parameters.

Step 8: Urban Typology

This step will focus on the typology and form of the building envelope. Different design strategies are developed to enable the creation of the 3D envelope. This step considers different criteria, objectives and constraints. The parameters responsible for the 3D generation are the maximum height and depth of the building, central court, type of the building generation and number of floors.

Step 9: Urban 3D Generation and Exploration

For each iteration of the design, end-users can analyze the performance indicators and compare between different iterations. In this interaction, the participation is enabled by giving the opportunity to understand and accept the solutions proposed. In this step, the generation and optimization of the 3D typologies is based on the requirements set by the end-users and the constraints defined by the experts (steps 1, 2, and 3 from the design framework).

Computer-Based Parametric Tools for Urban Planning

For urban planning to be effective, it is essential to approach it with a strategic lens, in order to clearly set goals, measure progress, and define and execute steps of a project. In this regard, a variety of urban planning software tools are designed to align the planning strategy with progress and support experts in the process of communicating, designing, simulating, analyzing trackable aspects of planning, and reporting.

In this chapter, a deliberate focus is put on the parametric computer-based systems, allowing for the search of solutions instead of drawing and/or simulating it.

To understand the strengths and weaknesses of these software systems, a descriptive and qualitative review of the main existing urban planning software tools is needed. This section addresses the requirements that such systems should meet; gives an overview of the four main existing groups of urban planning software tools, communication tools, designing tools, performance simulation tools, and data analysis tools; and details the devices that can be used to strenghten engagement and participation.

Requirements for Urban Planning Participatory Parametric Tools

Flexibility

The flexibility in the computer-aided parametric tools can potentially facilitate exploring different design strategies and different variations in the design solutions. A flexible design process helps in reducing the top-down design approach, and it can be enabled by giving the possibility to the end-users to set their inputs and compare different solutions through a participative process. The degree of the flexibility to modify and explore different design solution is defined by a certain range for the value of the input parameters. These values should be defined in advance depending on their types.

Easiness to Use and Visualization

From the perspective of the experience of the designed project, the visual exploration in a computer-aided parametric tool should be easy. Hence, the creation of this model can be difficult especially when dealing with complex geometries. Modelers should deliver parametric models in which users only need to manually move sliders to perform variation on the design or proceed to an automatic generation of design solutions.

Moreover, the results (geometries and associated simulations) should be presented in a way that is understandable for non-experts. The numerical values and results of the simulations should be meaningful for them so they can foresee the evaluations and impacts that are presented. To achieve it, software solutions might:

1. Present a comparative assessment of the different design solutions and their performance.
2. Translate the simulation values into more visual understandable indicators with a color range to indicate if the values are acceptable of not.
3. Present the simulation results with graphical icons and representations giving more meaningful understanding of the features of indicators being simulated.

Input and Shared Knowledge

Making the participation accessible in different design scenarios implies:

1. Collecting and understanding the needs and requirements of a group of end-users. These needs can be collected and explored with different devices; these devices enable the end-users to input their requirements and preferences. These tools should not only facilitate the experts to collect the end-users requirements but also integrate these requirements in the design solutions proposed.
2. Creating a shared information and knowledge between different actors to create a transparent design process by allowing the exchange of information and knowledge between experts and end-users in both directions.

Other Architectural Considerations

Deploying such tools on projects obviously faces more usual constraints associated with BIM and GIS tools. Indeed, besides being available, the datasets must comply with requirements associated with the purpose of their usage. In particular, urban planning requires territorial data that can either be public (e.g., cadastral GIS, often

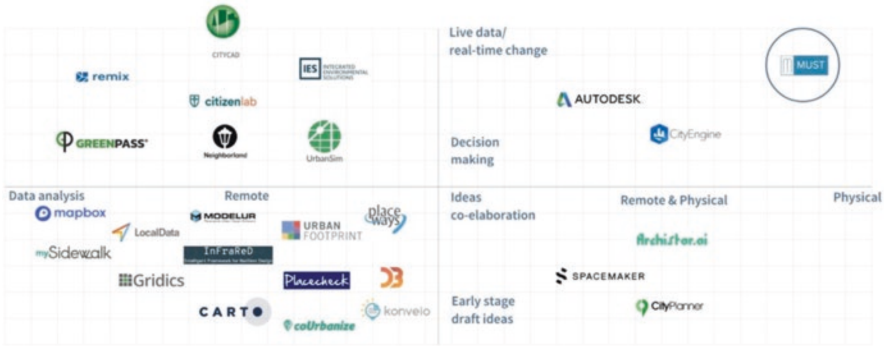


Fig. 7.7 Classification of the tools' positioning (type of consultation/stage of consultation)

providing open data), private (information on properties and land use, energy consumptions), or even data owned by public administrations but not disclosed (e.g., technical services).

It might be mentioned that such systems should rely on various sets of siloed data, thus requiring decentralized system architectures, and offer services via API interfaces connecting the underpinning systems. Moreover, relying on data standards is proven to facilitate this kind of architectures, especially when deployed ad-hoc for a given project. In relation with urban planning, CityGML (cities) and IFC (buildings) standards are applicable.

Existing Software Tools for Urban Planning

More and more systems are available on the market to support urban planning initiatives. This section attempts to describe those software tools developed and accessible in the market. The methodology underpinning this review includes a classification of the main existing software tools in the market, conduct of interviews with relevant stakeholders, and organization of an interactive online seminar to further present and assess the results achieved (Fig. 7.7).

As part of this process, identified tools were classified into four main groups, namely, (1) communication tools, (2) designing tools, (3) performance simulation tools, and (4) data analysis tools. A given tool can belong to several of these groups.

Communication Tools

Guiding an urban development within a new or existing community while considering public and environmental welfare is among the main responsibilities of experts active in planning fields. Convenience, efficiency, equitability, and sustainability are among factors that promote longevity and reduce the risk of disasters in a certain urban context. With urban planning software tools focused on communication among stakeholders, co-design, co-creation, and co-working methods are gaining momentum, resulting in creative approaches that consider broader design aspects from various perspectives. The objectives of these growing communication-based civic engagement/data platforms used in the public planning process revolve around connecting, engaging, reminding, and inspiring stakeholders via different methods while building trust by collaborating across teams and inviting public feedback. Collaborating with citizens, to better understand their preferences and aspirations, sustaining engagement by organizing events, distributing follow-up surveys, and raising awareness all address the unified goal of finding out what a place and its people can tell us.

Communication software tools within urban planning have the power to transform how planning and real estate teams connect with the community by empowering citizens to share feedback with the help of such tools. These two-way conversations are divided into four steps.

1. Idea collection: gathering suggestions per theme in a certain urban context and starting a discussion from there. Aggregating different information in an entire environment and answering the question of – "what happens if you build here? What will the impact be?"
2. Comments and votes: letting citizens react by voting for launched discussions and commenting on the ideas.
3. Surveys and Polls: collecting the feedback of citizens on a list of defined questions.
4. Scenario planning: offering citizens the opportunity to pick between several options that are aligned with the policies of the neighborhood to be further studied and implemented.

Designing Tools

Urban planning software tools operating within the physical design process steps are primarily used to build initial sketches and masses of building forms within an urban environment (e.g., Archistar and Spacemaker in Fig. 7.7). The output of these tools will eventually operate as the foundation of final products such as three-dimensional models, technical details (quantities, drawing sheets, and construction details), presentations, and walkthroughs. Along with the analytical and design skills and experiences of experts, these tools assist the planners in assigning different land uses and calculating urban control indicators such as floor area ratio or the required number of parking lots.

One of the advantages of using designing and modeling is the fast-learning curve and their wide compatibility with other software tools. This group of tools is bundled with additional software or plugins which serve different goals such as enhancing the quality of final product layout, interactive presentations, and real-time visualization and animation software. Furthermore, their compatibility with report creating and plan to graphics converting tools provide advanced design modeling potentials.

Performance Simulation Tools

Another important software tool group in urban planning is performance simulation. Performance simulation is widely implemented in automotive, aerospace, and multiple other industries. However, its adoption in urban planning and construction has been limited compared to the other fields, due to the lack of affordable tools, as well as the specialized knowledge required to successfully use simulation. It is important, however, to emphasize the emergence of cloud-based tools and their strength in reducing such barriers. Fluid flow simulation and finite element analysis hold great promise for the architecture, engineering, and construction (AEC) industry, giving architects, planners, and engineers the ability to predict, optimize, and plan the performance of buildings in the early stages of the design process both independently and within an urban neighborhood.

Efforts to make simulation affordable and accessible for everyone are turning this technology into a no longer impossible task for urban planners. Online platforms specifically designed for performance simulation and analysis of neighborhoods make simulation widely accessible for planners and users. Below are examples of types of analysis that urban planners can achieve with the assistance of performance simulations.

1. Simulate the application of urban policies: urban policies, such as densification (infill) or urban expansion (landfill), transportation systems, reforestation, risk mitigation, energy and water efficiency measures, and construction of new urban services such as schools, hospitals, parks, and other civic spaces can be simulated and measured by the assistance of performance simulation tools focused on policies and their impacts. Such tools identify which policies will help urban areas in reaching their goals, by applying different indicators, including water, energy and land consumption, infrastructure and municipal services costs, intersection and population density, greenhouse gases emissions, green areas per capita, proximity to job opportunities, and urban amenities. Results are organized in sets of presentable scenarios for further data-driven analytics.
2. Optimize thermal comfort: air velocity, temperature, and humidity can be accurately predicted and analyzed with the help of wind flow analysis streamlines and fluid flow simulations, allowing architects, planners, and engineers to visualize the airflow and evaluate temperature gradients, air distribution, or velocity plots.
3. Organizational performance simulation: Combination of design experience with digital technologies forecasts the social, economic, and environmental impacts of development within an urban context. Such simulations result in urban plan-

ning and design strategies that deliver sustainable spatial, land use, and transport networks based on land value modeling and organizational performances.

4. Decision support for urban energy simulation: Such simulations indicate the energy demand of a neighborhood, respecting the occupants' behavior and accounting for a range of commonly used heating, ventilation, and air conditioning systems. Determining the energy supplies issued from renewable sources, including the radiation exchange, is driven by a specific urban context generated by a range of commonly used energy conversion systems.

Data Analysis Tools

Mostly accessible as open platforms, data analysis tools are used by planning professionals and experts active in data science domains. Statistical analysis on geoprocessing models enables users to test and predict the behavior of an urban environment and solve complex scenario problems subjected to different conditions. Such tools use scalable numerical methods that can calculate mathematical expressions despite complex loading, geometries, and material properties.

Population movement, transport modeling based on data science, and big data within an urban context have the potential to present a flexible and transparent approach to enable stakeholders to exploit the potentials of urban networks. Below are examples of areas that data analysis tools are used to increase the resilience and adaptability of infrastructure.

1. Built environment: Assess existing conditions and land use down to the parcel level with urban, environmental, and mobility data.
2. Community resilience: Analyze and intersect vulnerabilities and policy interventions at the city or neighborhood level.
3. Climate and hazard risk: Evaluate the impacts of climate change and natural hazards on urban contexts and infrastructure.

Devices Enabling Participation

Tangible Devices

The applications based on tangible user interface (TUI) require a specific input output device called a tangible table-top device. It is accompanied by a minimization of interactive diversities reduced to the components such as the screen and interaction to what can be achieved with a mouse or keyboard (Ishii 2007). According to Ullmer and Ishii (Ishii and Ullmer 1997), tangible interfaces contribute in giving a physical and virtual form to digital information while using physical artefacts to control the "computational media" (Fig. 7.8). An early example of a TUI from the

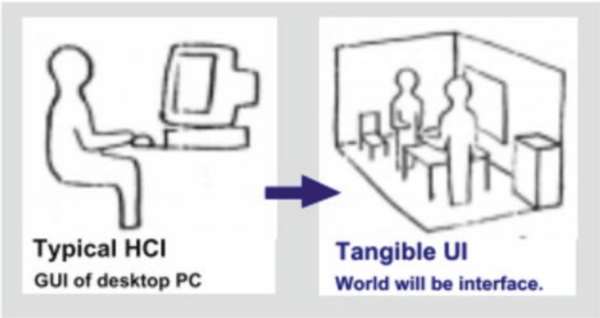


Fig. 7.8 From GUI to tangible user interfaces (Ishii and Ullmer 1997)

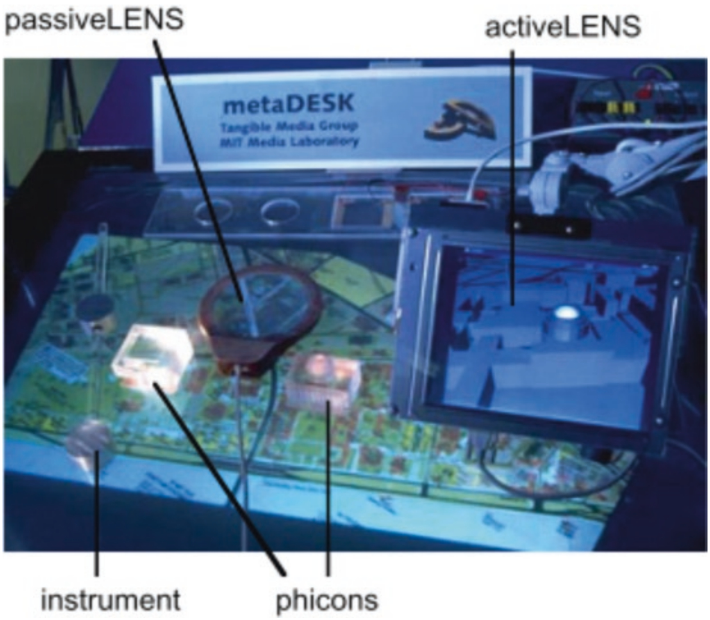


Fig. 7.9 MetaDESK (Ishii and Ullmer 1997)

1990s is the metaDESK (Fig. 7.9) in which the user could interact with a map of the MIT campus.

This technology provides a collaborative environment enabling the visualization of the data on a table-top. Adding physical shapes to the displayed information and to the controllers (sliders, inputs, etc.) enhances the human ability to identify the solutions and to control the related objects (Rodrigues et al. 2012). Digital environments such as tangible table-top combined with physical objects are important tools to improve a transparent design process (Ishii and Ullmer 1997). Tangible table-top systems can be foreseen as a participatory technology that helps to increase the engagement of end-users and community in urban planning (Maquil et al. 2008; Wagner et al. 2009).

Augmented and Virtual Reality

In architecture, 2D and 3D modelling tools now complement traditional paper sketches, drawing, and physical models. In addition to this, CAD tools allow the simulations of architectural projects. Virtual and augmented reality are considered a technique that is used to explore architectural projects. Virtual and augmented reality demonstrated a way to merge physical and digital artefacts by using virtual projection. Augmented and virtual reality started to appear in the architecture, engineering, and construction industry (Ben-Joseph et al. 2001; Morton 2001; Shen et al. 2002; Rodrigues et al. 2012; Danker and Jones 2014; Figen Gül and Halıcı 2015). Their main purpose of virtual and augmented reality is limited to improving the visualization of 3D models.

Nowadays, the urban designers and planners are also experimenting several innovative solutions for city and urban environmental visualization in virtual or augmented reality (Ben-Joseph et al. 2001; Hanzl 2007; Kaftan et al. 2011; Cirulis and Brigis 2013; Chowdhury and Schnabel 2018; Gun et al. 2020). These solutions are providing urban visualization allowing merging real cities with virtual three-dimensional (3D) buildings, with the objective to improve the immersion into urban planning solutions (Cirulis and Brigis 2013). From this perspective, a research project has demonstrated that virtual reality (VR), when properly used, allows a meaningful participation of the community or end-users (Gordon and Koo 2008). Other benefits for the application of VR and AR in urban planning were related to the time saved in the design process and the presentation of realistic solutions (Shen et al. 2002). These research studies showed the potential of computer-aided parametric tools when coupled with other tools and devices (Unity3D, ESRI CityEngine, tangible interface, etc.) to help experts in the decision-making of urban development with limited or a low-level focus on participatory approaches. The participation remains in these cases limited to information or consultation levels. However, despite the visualization function provided by these technologies, the main issue is to find how to use augmented reality to allow participation in the urban process.

Conclusion

In this chapter we have traced the evolution of participation approaches and tools in urban planning and how these aim to address key planning performance indicators at different planning stages. Based on this, we elaborated on different types of tools for civic engagement in urban planning: physical planning tools, physical/civic engagement tools, civic scenario planner tools, and data analysis methods. Major gaps have been identified among these tools, as well as the necessity to bridge them.

Building on this discussion, a framework for participative performance-driven urban planning is introduced, as an innovative method that aims to explore novel forms of citizen involvement within urban planning activities. The results of a benchmark of a wide range of tools using types and stages of consultation and the KPIs they address are then presented. This study revealed the degree to which the digital tools create an inclusive environment to exchange and implement urban planning-related ideas and the extent to which they could lead to an integrated and coherent engaging method for citizen engagement.

The framework starts first with identification of the key components to be included in terms of (1) the design process, (2) the participatory interactions to be implemented in the design process, and (3) the devices and tools to allow the participation. The framework presented in this chapter addresses the need to develop methods and tools to support the performance-driven design process with different levels of participation and end-users' feedback to be integrated in the decision-making processes for urban planning. The review of the existing tools supporting the urban planning have identified a gap between the participatory approach and the urban planning. The existing tools and platforms for urban planning are encouraging a top down design process and only allowing a lower level of participation. The modalities of participation used in architectural practice were mapped with the ladder of participation of Arnstein (1969). In Fig. 7.10, we show the possible modalities of participation used in architectural project with a map to the level of participation allowed by these modalities.

The developed framework should be considered as critical tool aiming to enhance civic engagement in urban planning processes.

This framework aims to break free from prevailing participation going off the top-down and autopilot process. It presents a theoretical and technological

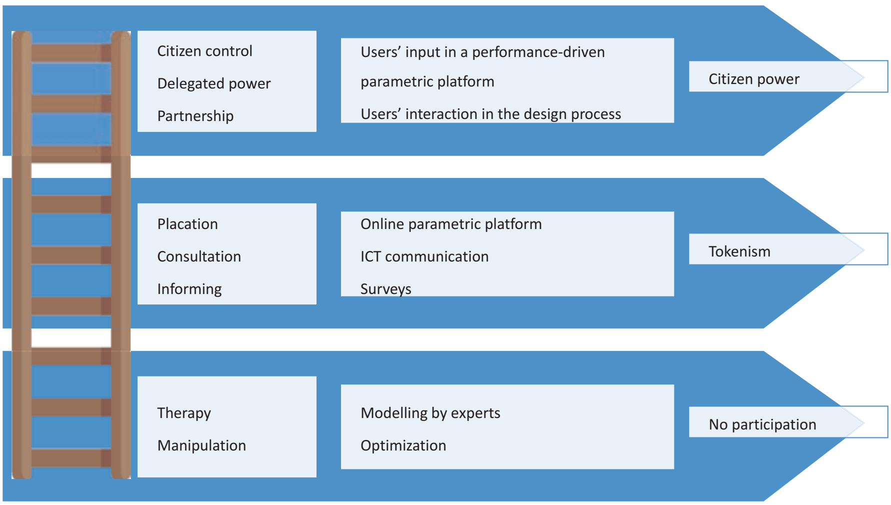


Fig. 7.10 A ladder of participation for performance-driven design. (Adapted from Arnstein (1969))

framework for including end-users' feedback and criteria in the urban planning process while also enabling the integration of social criteria, where the end-users are able to input, adjust, and define their own preferences and requirements in a participative approach.

This framework is a digital shift from a traditional design process to an experience design where the use of different participatory devices allows a better understanding of the design solutions which also keeps a transparent relation between the input and the solutions.

Another aspect enabled by the framework is the creation of a meta-design as a focused "solution space" and iterations that satisfy the needs and requirements of the end-users. The benefit of meta-design model is in the ability given for the designers to accommodate changes and modifications in the design that can be asked by the end-users with less time and effort and a guarantee that the requirements are still considered in the iterations. Another benefit of the meta-design model is the ability given to the end-users to assess, investigate, and compare between different iterations for the design solutions.

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