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Designing an incubator of public spaces platform: Applying cybernetic principles to the co-creation of spaces

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ABSTRACT

The paper is based on the experience of creating and piloting a functioning ‘Incubator’ crowdsourcing platform for designing public spaces in an estate regeneration project in South London. The paper uses a cybernetics framework to analyse and present the way the platform itself was created and how issues of effectiveness, efficiency and equity were dealt with. It explores the generic qualities of interface and reviews applications of variety reduction in established crowdsourcing CS) models. It briefly presents the legal and socio-spatial parameters (like property rights) associated with the creation of the Incubators platform as well as the generic rules applicable to human-spatial relationships, based on studies exploring human-spatial interactions. Practical constraints including costs, catchments, life-span and meaningful feedback are looked into, followed by a discussion on social and political limitations associated with this form of public participation. The paper explains how those constraints where taken into account when establishing the operational parameters of the software platform and the experiences gained from the operation of the platform. Challenges and complications, such as the exclusion of actors, are identified together with the responses encountered in practice. While the Incubators platform succeeded in attracting younger planning participation demographics, older demographics were marginalised by the platform’s graphical user interface and social networking features. These findings highlight why, in spite of what it promises, ‘crowdsourced urbanism’ is prone to similar traits with those of analogue participation. In that sense, creating a CS platform which could convey the grass-roots ideas of actors and users of urban spaces in an efficient way that could be applied to a broad range of planning systems, appears to be a challenge.

1. Introduction

The rise of crowdsourcing technology to assist participatory planning, promises to offer a break with planning and design practices where individuals react to planning proposals. This can be seen as an opportunity – alternatively even as a threat, in the sense of where crowdsourcing might lack local legitimacy or democratic accountability. Much of the focus of technology and participatory democracy has been on other issues – the technology itself, smart cities etc. – but not necessarily sensitive to the details of place.

This paper discusses the experiences gathered from the process of creating a three dimensional, web-based Crowdsourcing platform to facilitate a Living Lab aimed at designing public spaces in three European cities (Torino, Brussels and London). In a novel theoretical application, the Living Lab process architecture was based on cybernetic principles and was implemented in analogue as well as in digital format. Once piloted, the process architecture was used as an input for an online ‘Incubator of Public Spaces’.

The paper focuses on how the Living Lab process architecture was developed, the key cybernetic principles that were adhered to during its design (most crucially: controlling variety) and insights from piloting the platform in London. It reports on an experimental online design platform – a device for allowing design ideas to be created and preferences expressed – recreating parts of the planning system, taking place in

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a reordered set of processes and stakeholders, online. The focus is on the context of the case, insights from options considered, alternatives trialled, and lessons learned.

Largely an online strategy, Crowdsourcing (CS) can be described as a process whereby an organisation posts a problem online, receives a large number of individual solutions to the problem, selects a winning solution and produces the solution for their own gain (Brabham, 2009). The CS methodology has been adopted by mass producers and service providers such as Procter & Gamble and Amazon (ibid.). While outsourcing involved sending jobs to external companies to primarily reduce labour costs (Howe, 2006), the concept of CS went a step further to tender tasks essentially to the end-users, or ‘crowd’ whose latent talents best addressed the task at hand (Howe, 2006).

The potential of CS platforms to engage large numbers of people in problem-solving, at low cost, and the idea that civic society might be mobilised to provide additional investment funding via Crowdfunding (CF) made platforms combining CS with CF particularly attractive propositions for planning-related tasks, at the age of austerity urbanism (Peck, 2012). Indeed, it is not difficult to imagine how a CS planning platform could fit into the “do-it-yourself government” practices which have proliferated across US cities following the latest round of post-2008 austerity (ibid, p.608). In the UK, Future Cities Catapult (2016) has identified a handful of online platforms which engage with the planning and development process, from plan making to project design. The majority of the platforms, to date, have been two dimensional, either reacting to drawings or photography based site specific examples, such as CommonPlace (https://www.commonplace.is/). The Incubators platform notably differs from these as it is 3D with an open ‘sand pit’ style to design options, in many way similar to the popular 3D modelling software ‘Sketchup’ (see sketchup.com) from Trimble, but focused on a specific area. Indeed it could be viewed as an early example of the now emerging move in urban planning towards the use of digital twins. As White et al. (2021) note, digital twins allow for the simulation of many options before taking physical action in the real world to identify the strengths and weaknesses of each plan. The concept of the Digital Twin, initially linked to product manufacturing by Grieves in 2002 (Grieves, 2015) with the concept of linking digital versions of manufactured products to their physical counterparts throughout their life cycle via a Digital Twin concept model. The model, according to Grieves (2015) consists of three main parts: a) physical products in Real Space, b) Virtual Products in Virtual Space and c) the connections of data and information that ties the virtual and real products together. In essence it is a model of a space in three dimensions with links back to the real-world, while also allowing design decisions and experimentation to take place. The Digital Task Force for Planning define this link as a Decision-Making Loop (Batty and Lin, 2022) using digital tools for a crowd sourced participation process linked to a 3D model, a Digital Twin. With this is mind, the preface around incubators builds on the view noted by Hasler et al. (2017) that digital tools increase participation by allowing more people to participate and produce input. It also makes it possible to reach new socio-demographic profiles such as young people and families.

Applying the concept of CS as a possible solution to the public participation process for planning projects, Brabham (2012) argues that the theoretical model of crowdsourcing addresses the planning profession’s struggle to enlarge the participation process to maximise and diversify stakeholder input in the design of solutions to urban problems. Brabham endorses traditional arguments stating that the planning process should be a holistic process (Alexander, 1964; Lane, 2005) enjoying the benefits of non-expert knowledge to view the planning problems from multiple perspectives. He implies that it is immodest to think that only professional planners can identify issues, prioritise on problems and develop planning solutions.

Furthermore, to identify how many ‘non-experts’ would be of value to a project, Brabham suggests a socio-economic solution. This addresses Arnstein’s notable criticisms of exclusion in planning practices (Arnstein, 1969), still referenced today (Lane 2005, Brownill and Inch, 2019; Ciaffi, 2019). Zhao and Zhu (2012) state that CS is a “collective intelligence system” and tapping into this medium will significantly improve the provision of sustainable design under conditions of austerity and in ways that embrace recent advancements in social media platforms.

In comparison to existing participatory planning methods, CS potentially further enhances the practice of participation by giving members of communities the power to actually design and alter their environments in a ubiquitous, flexible, and even more holistic manner. Although as we have noted, these are often limited in scope to more traditional two dimensions, the Incubators platform develops the concept and we would argue provides a glimpse of the future of CS in urban planning, building on the five key topics and further developing the work by Batty et. al. (2000). These involve:

1. Representing the geometric and geographic form of the system in question in terms of buildings, streets, land uses etc, at different geographic-geometric scales, and using different types of media;
2. Modelling design and relationships between the various components of the built environment;
3. Enabling the designer and the public to sketch different alternative designs which address the problem in question;
4. Visualizing the 2D map geometry or geography in 3D at different scales;
5. Tying together all this various software in a networked participatory digital environment - a virtual design studio - where various users might participate and collaborate in the process of design.

Seltzer and Mahmoudi (2013) highlight the differences between participation and CS, highlighting that CS is a form of open innovation. According to Seltzer and Mahmoudi (ibid.), planning’s portrayal as a network-based activity with the problem of coordinating numerous institutional and other interests towards a final plan presents a strong case for the application of CS techniques as a means for engaging a diverse crowd and tap into the knowledge and creativity of crowd ‘members’ (Seltzer and Mahmoudi, 2013). This is in spite of the apparent differences between planning processes and manufacturing industries. However, whereas public participation is expected to give citizens affected by a spatial plan an opportunity to voice their concerns and an opportunity for those likely to be excluded from plan-making to provide insight, CS is not necessarily bound by the same expectation (ibid., p 8). From and ideal-type perspective therefore, CS is a solution to a technical problem while participation is a solution to a political problem yet, when applied to a planning context, CS can be perceived as a potential tool in tackling both technical and political problems at the same time. With planning’s increased reliance on methods of e-governance, it is necessary to explore the social implications tied with the implementation of such design tools into participatory design processes.

Following the introduction, the paper presents the key elements of cybernetic theory and looks into the existing literature which explores the issues surrounding the application of CS in planning and urban design. In Section 3 the paper explains the main methodological steps undertaken in the process of process design and framework development, the stages it went through and the eventual outputs. Section 4 is dedicated to the application of the framework in the case of London and the feedback it provided into the Incubators web platform design. The last section summarises the conclusions drawn from this experience and the future directions research could take.

2. Cybernetics and CS applications in urban planning and design

2.1. Cybernetic theory and urban complexity

The application of (second-order) cybernetics to the process of managing spatial transformation has been thoroughly discussed in

Karadimitriou (2010), who reviews the main principles of cybernetics and the links between cybernetics and the management of urban transformations' complexity. In his succinct review of complexity theory, Manson (2001) defines "aggregate complexity" as the study on "how individual elements work in concert to create systems with complex behaviour" (p.405). Connected to the principles of holism and synergy, this kind of complexity applies to socio-spatial configurations, as the ones influencing the features of the public realm. Aggregate complexity's definition relies on the concepts of *relationships between entities, internal structure, external environment, learning* and *emergent behaviour* (ibid., p.409).

Cybernetics concerns the management, or control, of diverse thoughts and opinions from different mind-sets that are essentially as boundless as the human race itself (Beer, 1959). Beer wanted to ensure that contributions are acknowledged and used towards a common goal resulting in a 'homomorphic' representation or a many-to-one relationship (ibid., p. 4). In cybernetics the functionality of a system is considered within the broadest context that can result in limited outcomes – insofar as CS is concerned, a large pool of ideas. The goal of Cybernetics is the management of actions and the optimisation of interactions within complex systems including government agencies or whole branches of the economy (Sandmeier, 2011). This scope captures the challenges presented by the planning system.

Ashby's (1956) Law of Requisite Variety states that in a situation where one system is controlled by another, the variety of the controlling system must be at least the same or bigger than that of the controlled system. Starting from this assumption, Glanville (1997) reflects on the limits of manageability of complex systems, and on the nature of controls: "*Systems rapidly become so complex, so rich in variety, that they are no longer realistically computable (they are transcomputable). Thus, questions concerning their controllability are raised.*" (ibid., p. 2).

Goodspeed (2015) parallels cybernetics to the concept of contemporary smart cities. These can be viewed through the lens of a socio-technical theory of action that places emphasis on social and technical factors (ibid. p. 81) and their complexity. Yet, he argues that the application of conventional cybernetic approaches in urban planning (e.g. through computer simulations) fail to capture the complexity of cities often because the model builders lacked good theories (ibid. p. 82). However, Goodspeed (2015) suggests that first order cybernetic models are essentially inadequate when dealing with *wicked problems*, usually found in social and political dimensions of society. These problems "… have no definitive description, involve value judgements, and take place in unique contexts that make it difficult to accurately test solutions" (ibid., pp. 85, 89). However, through advancements in IT, it is possible to explore 'New Cybernetics' (Glanville, 1994) in terms of reducing variety whilst at the same time ensuring that the planning process remains inclusive. Managing complexity in spatial planning often includes an element of variety control, in the sense this term is used in second-order cybernetics.

Insofar as 'variety control' in spatial planning is concerned, Karadimitriou (2010) discusses it in great detail and concludes that it is a key feature of systems aiming to manage the process of spatial transformation. In his view, given the grave ethical and technical dilemmas arising, the main challenge is to "…put in place mechanisms that allow for the widest possible representation and that permit a flexible examination of the widest possible range of available choices…".

2.2. Managing complexity with the use of CS platforms

The essence of a CS challenge is the management of the potentially vast pool of resources – specifically the brokering of the links and connections between the different parties involved: the *knowledge seekers* and *knowledge suppliers* (Howells, 2006; Zogaj et al., 2014). This is, in effect, an attempt of a relatively small group of individuals (say, the project management team ie the 'controlling system') to harness the 'meanings' generated out of numerous communications between the potentially quite large number of members of a group who are trying to understand and solve a 'problem'. A public space incubator CS platform could therefore be seen as an attempt to expand the limits of Ashby's Law of Requisite Variety by collecting the 'meanings' emerging out of the controlled system (ie the crowd) and translating them into spatial configurations.

Insofar as the development of a CS platform is concerned, Malone et al. (2010) recommend the to take into account the following parameters:

- There must be a goal for the entire exercise
- There must be a clear structure or process
- Staffing must be adequate in numbers and breadth of disciplines
- The type of incentive mechanism should be decided and resourced in advance

Zogaj et al. (2014) identify several risks associated with CS:

- The risk of disclosing valuable knowledge as well as intellectual property or proprietary information (Rayna and Striukova, 2010)
- The risk of obtaining either insufficient submissions or low quality contributions from the crowd (Hoßfeld et al., 2012; Leimeister et al., 2009)
- Crowd members' solutions might be difficult to exploit within the firm (Blohm et al., 2011)
- Risk of crowd misbehaviour i.e., submission of irrelevant 'solutions' (Zogaj et. al, 2014)

They note (ibid.) that in order to manage such challenges, crowdsourcer 'testCloud':

- Enforced secrecy about decisions and contributions of individual members of the 'crowd, through confidentiality agreements (non-disclosure-agreements).
- Applied extrinsic (monetary) motivation, to address the risk of insufficient / low quality submissions. However, intrinsic motivation modes were also encouraged where testers are driven by the desire to solve challenging problems (ibid, pp. 397, 398).
- Identified 'bugs' using other members of the crowd, a form of quality assurance management which corrects 'misbehaviour' (ibid, p. 392).

The management of complex processes intrinsically relies on the control of variety (Ashby, 1956; Glanville, 1997) via attenuation and amplification in the controlling and the controlled systems. This happens through the application of ***filters,*** identified with the symbol **Ø** in Fig. 3 (Section 3). Filters occur at many stages in the process: in most instances, they are individual characteristics (e.g. ideologies, understandings, competencies) or structural characteristics such as the social and economic milieu affecting actors' choices. Ina few other cases they are the result of an active and conscious selection (design choice aimed at simplifying the multitude of laws and regulations into a set of software rules, or the in the creation of a library of symbols representing items of a public space).

2.3. Challenges of implementing CS platforms

CS/CF is part of a wider shift in traditional participation methods from using physical platforms to utilising virtual ones. Prior to introducing how cybernetic principles could be applied in the case at hand, it is worth exploring here the key challenges of implementing CS, in order to understand how cybernetics addresses them. In participatory e-planning, stakeholders express their positions and interact with each other on platforms such as websites, software or applications (Saad-Sulonen, 2012). There is a wealth of literature supporting the idea that e-participation would increase inclusion of different social groups (Seifert and Peterson, 2002) and provide better access to information and transparency (Bekkers and Homburg, 2007) as well as being more cost efficient compared to traditional methods (Noveck, 2009).

On the other hand, there is a number of wicked problems related to the wider practices of participation, among which, limitations of time and costs in the policy making process, lack of interest, weak expertise (also rational ignorance) or difficulty to include hard-to-reach groups (Irvin and Stanbury, 2004; Roberts, 2004; Natarajan, ed, 2019). In the specific case of civic CF, Davies (2014) notes that "an individual's ability to participate in civic crowdfunding is mediated and controlled by three main factors: their access to the technology platform, their possession of the skills necessary either to run or support a campaign and their financial resources." (ibid., p.345).

Demographics (age, gender, ethnicity etc.) are important indicators of IT capacity and accessibility around the world. On a local scale, these demographic are indicative of potential exclusion of members of communities. This is of crucial importance given that CS has been touted as a revolutionary approach to public engagement in planning processes (Jetzek et al., 2012), where the objective is to capture the views of as many members of the community affected as possible.

Lack of incentives for communities to participate may result in the production of low quality outputs. The skewed demographics and the exclusion of those without access to technology may also result in the production and promotion of outputs that wouldn't be hugely beneficial to the wider community. Thus, CS could become a tech-savvy method of tokenism if these issues are not addressed. The question is, how could an Incubator of Public Spaces counter those constraints?

After acknowledging that the 'wisdom of crowds' is derived not from averaging solutions but from their aggregation, Brabham (2009) discusses the challenges of implementing CS. Critics of Brabham's optimistic outlook on CS and to an extent Brabham himself, point out the perceived exploitation of participant time and resources and the exclusion of people who do not have access to the web, or a good command of English (Brabham, 2009; Busarovs, 2013). Consequently, from a corporate point of view, crowdsourcing is more efficient and effective when participants come from a homogeneous group of wealthy, well-educated, and well-connected people (Brabham, 2012). Essentially, those without access to the internet, the unskilled, and/or the poorly connected are unable to contribute to such processes. This side-effect becomes a poignant concern when the CS model is applied to the participatory practices of urban planning.

In its present state, CS often fails to reflect the choices of a broad demographic. CS is biased to favour those with a degree of expertise on a particular subject. In direct participatory democracy decisions are made by the people affected by them (Polletta, 2013) thus the perceived biases of participatory democracy can be applied to the theoretical basis of CS. For example, the criticism of participatory democracy as lacking 'mass participation', where the "flaw in the pluralist heaven is that the heavenly chorus sings with a strong-upper class accent" (Pogrebinschi and Samuels, 2014); in addition, public debates do not always attract large numbers (Schattschneider, 1963, p. 316). As such, CS/CF can be described as inherently biased in favour of the privileged few. Brabham, (2012) observed that the core participants of CS, an exclusively online activity, are wealthy, well educated, and well-connected. Thus, there is a lot of potential of marginalisation of less privileged communities if CS is applied in its currently packaged state. This raises questions similar to those raised by Alexander in his 1975 Oregon Experiment (Healey, 1992):

- Do people have enough stake in a community which they do not actually own to make responsible decisions?
- Do people have the time to take part in these design processes?
- Are people able to express their ideas without being ridiculed?

Overall, the challenges to the implementation of CS platforms, as identified in the literature can be summarised as follows:

2.3.1. Structural challenges

Municipalities and organisations are often the initiators of civic CS/CF campaigns. Moreover, most platforms do not allow individuals and community groups not authorized by government to launch projects (as in the case of Citizinvestor). On the other hand, platforms open to any individual or group provide a new tool for these stakeholders to acquire agency over other parties with whom they share the same environment, namely, a local community (Davies, 2014). The same actors who start CS campaigns are often in charge of the delivery of the projects once they reach the funding target via CF or otherwise. However, this also means that people who backed the project might not achieve the expected level of ownership and control on the assets produced, endangering the notion of participation as formulated in Arnstein (Davies, 2014).

2.3.2. Learning challenges

The experience of public participation geographic information systems (PPGIS) is instructive. When used as a technological tool to facilitate participation, CS platforms face limitations similar to those faced by PPGIS. Although they use less complex tools than GIS, as they were created to target a non-expert audience, learning how to use a CS platform may still require a certain amount of investment in terms of time and training. This could turn away people who are technophobic or decide to be "rationally ignorant" (Krek, 2005). It should be remembered, however, that solutions to overcome this gap may not necessarily imply training but simply a more flexible and adaptive structure which embeds consolidated habits into an innovative system.

2.3.3. Equality and consensus

Calhoun provocatively claims that in order for goods to be considered truly public, they must be agreed upon through a process of deliberation (Calhoun, 1998). This means that a deeper look should be given at how CS/CF platforms allow debate to take place. The type of participation that (civic) CS and CF campaigns allow for is limited to the choice between supporting a proposed idea or not. This binary choice is not truly consistent with the principles of Living Labs, which are based on co-creation and discussion.

As Davies notes, disagreement and consensus building, in the current model of CS/CF, happen, if so, elsewhere (among the offline community) and in other phases, preceding the posting of the campaign, while platform interfaces are not equipped to capture dissent. Furthermore, the crowd's decision whether to support the project or not, is affected by a fundamental asymmetry of information between them and the project promoters due to the constraints imposed by the platforms' interface. For example, in Spacehive the user may make his/her choice based on a brief description and a visualization of the project (Rembeck, 2014). This appears to be even more in contrast with the principles of a democratic consultation when a campaign is launched with the intention to create the political capital necessary to win regulatory approvals (Davies, 2014).

2.3.4. Implications for taxation and local government

As CS/CF campaigns grow in number and popularity, the need to achieve a better understanding of their implications for local taxation increases too. It has been noted that the possibility to voluntarily fund a project is directly connected to personal interest and may erode the legitimacy of local taxation (Boyer and Hill, 2013) and (Bailey, 2014). Furthermore, civic CF often aims at creating new services which in some cases lie outside the capability of the government (Davies, 2014).

To sum up, civic CS/CF could well be a potentially disruptive practice in the already complex relationship between the public sector, taxation and service delivery. However, a final consideration must be given to Elinor Ostrom's position, who has repeatedly advocated for the transition of the public sector to a polycentric system (Ostrom, 2005). Her studies on the commons bring evidence of a community's capability to self-organise service delivery (Ostrom et al., 1994).

It would seem that while social networking / web-based communication platforms have taken off in recent times, spatial planning, despite its deliberate attempt to exploit this growth to disseminate information and encourage participation, has largely been unsuccessful in captivating the interests of the representative user groups (Evans-Cowley, 2010). This disinterest can be countered through the persistent encouragement of signed up members and the active facilitation of discussion via low entry barriers. However, conventional social media does not easily allow for the comprehensive distribution of information necessary for effective public participation (Evans-Cowley, 2010). Therefore, an Incubators approach would need to employ methods that proactively mitigate this effect to ensure that users aren't excluded from the respective urban design and planning processes. Transcending a purely web-based platform or providing free access via public hot spots may be ways to address this.

2.4. Identifying key actors in the CS and LL process

The identification of actors in Living Lab (LL) scenarios is crucial in understanding the types of inputs and the management of content in the Incubators crowdsourcing platform. Both Incubators and LL scenarios have a diverse range of actors and end-users who work closely together to deliver a viable end product, where it is crucial to acknowledge and then efficiently accommodate this diversity captured by roles presented by both Heikkinen et al. (2007) and Nyström et al. (2014). Doing so, will potentially safeguard the richness of the contributions from the crowd. As such, it is necessary to explore the most effective forms of user interfaces to manage a broad array of actors and users and their potentially diverse inputs.

Living labs (LL) are described by Nyström et al. (2014) as environments where stakeholders from public-private partnerships "create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts" (ibid., p. 483). As such, similarities can be drawn between the working environments of LL and Incubators, where users are not only sources of information but are testers, developers, and designers of innovation (ibid.). In fact, Nyström et al. (2014) cover 10 unique roles actors can play in the process of developing a CS platform.

In terms of identifying actors, the Incubators research team identified four user groups in the London case study, following Hudson-Smith (2015):

- The people. Citizens who want to solve their real-life problems and include existing / new residents, any community association, prospective residents, entrepreneurs, small business operators (market stall owners)
- Utilizers. Enterprises interested in businesses in the area.
- Enablers. Public sector actors and developers.
- Providers. Domain experts, universities, consultants, technicians including the Incubators team, urban designers, master planners, architects/landscape architects, retail/tourism consultants.

2.5. Cybernetic principles for planning and crowdsourcing

As with CS/CF, the goal of applying cybernetic principles to spatial planning is a synergetic and democratic vision whose characteristics are listed by Dahl (1982):

- It should be based on democratic decision-making: its foundations should be those of direct democracy.
- It should be layered in a way that mirrors the 'emergent' nature of the issues that it is called to deal with.
- It should be operating on the basis of subsidiarity, higher levels should not intervene in matters that the lower levels have the competency to deal with.
- It should be scale-free: each level should have complete responsibility for all matters arising within that level including strategic considerations.

Essentially, an Incubator approach needs to acknowledge the importance of communications between subsystems by creating a clear image of the perspectives and goals of actors through feedback loops, enabling an adaptable co-evolving system (Karadimitriou, 2010, p. 442). In such a system the essential role of the planner is to assist the efforts of society to exert influence on the self-steering processes guiding any socio-spatial system. In such a system, direct democracy would be the most effective mechanism to manage variety in an ethically acceptable way (ibid.).

The different groups of stakeholders affected by (or influencing) the transformation of places, form a system with its own internal relationships. At the same time, a wider *environment* surrounds this structure, e.g. local and national governance, planning regulation, or everybody who uses a specific public space. In such a context, the process of transformation of space is driven by *learning,* and affected by episodes of *emergence*.

In the case of a crowdsourcing campaign, a determining factor is the perception that each stakeholder has on the project's features, as influenced by inertia (resistance to change) derived from past learning (Boyer and Hill, 2013). It is worth making a distinction between individual learning, namely, citizens becoming progressively familiar with a CS process and organizational learning. Organizational learning is essential for the design of a successful campaign, and, in this perspective learning is a dynamic and continuous evolutionary process, challenging what has been consolidated through previous experiences (McDougall and Beattie, 1998).

On the other hand, the inertia to individual learning by a public of non-experts in contexts such as e-participation experiments is often down to rational ignorance (Krek, 2005). This concept, first elaborated in public choice theory, has been applied to participation in urban planning. In this perspective, the citizens' choice not to participate to planning processes, especially the ones involving the use of technology, is deemed as rational, because the cost in terms of time and effort to become an informed participant and skilled user of e-participation tools would be too high.

Eventually, the high degree of complexity of socio-spatial processes, such as these pertaining to the design of a public space, often produces unexpected results (*emergence*). Referring to Clarke's (2003) abstraction of the main components of an urban modelling tool, the interface then could be seen both as the support on which *outputs* are displayed, or communicated to the final user as well as the filter between *inputs* and *outputs*. On one side this filter, whose purpose is to "wrap" *algorithms* and *assumptions* (ibid.), applies variety reduction that allows the user to operate the model. Nonetheless, for the very same reason interface makes the in-between process of modelling often un-intelligible, virtually unknowable for laymen.

> *"Today the interface is ubiquitous and hidden to view. It is both the bottleneck through which all human relations to and through technology must pass, and a productive moment of encounter embedded and obscured within the use of technology. It is a disputed zone, a site of contestation between human beings and machines as much as between the social and the material, the political and the technological."* (Hookway, 2014, p. ix)

An Incubator software is intended to be a tool for participation. However, the design of the software itself can silently enforce *ex-ante* a specific power configuration on the actual participation process. In order to avoid this, it is essential to a) achieve a shared acknowledgement of this risk among the stakeholders and experts participating to the software design and b) tackle this issue by making the process as transparent and open as possible.

3. Method: The development of the placemaking process and framework

The researcher team was not only conducting an experiment by creating and using the platform, but also participated moderately in the regeneration project process insofar as the design of the public realm was concerned (i.e. the team maintained some distance from the regeneration project in order to still have an 'outsider' perspective of it).

The first milestone in this 'participant-observation' approach was to create a framework whose draft was released to consortium partners in June 2015 and was discussed in a consortium meeting in April 2016. This offered an opportunity to collect extensive feedback on the framework from colleagues and stakeholders. It was also the occasion to refine the role played by the platform in the whole incubators process, especially given the experience from the implementation of an analogue crowdsourcing method in Brussels.

After identifying user groups based on Hudson-Smith (2015) - see Section 2.4- the task was to provide a framework of relationships, conceptual and procedural devices relating different actors to different types of space (see Fig. 1). The framework had to be adaptable to different levels of scale, access and use, reflecting the differences between various studies. Initially, the abstract diagram in Fig. 1 was created and put to the test.

The framework in Fig. 1 describes our initial understanding of the design of a spatial transformation process mediated via a CS (and a CF) platform which is based on a set of selection rules and symbols, created by technical expert team(s) (Hudson-Smith's 'Providers'). The experts bring their own values and influences in the process and are bound by their understanding or the regulatory context and the input they receive from relevant workshops where applicable. Actors/Stakeholders (Hudson-Smith's 'The People' and 'Utilisers') interact (Step 1) with the CS platform and its representation of an existing socio-spatial configuration (Step 2) to transform it into a representation of an intended socio-spatial configuration (Step 3). A second round of changes occurs during the CF process, when a similar representational transformation loop occurs (Steps 4–5–6). Finally, the crowdsourced and crowdfunded socio-spatial configuration could be implemented (Step 7) via the mediation of a Local Authority in the case study examples (ie Hudson-Smith's 'Enabler'). The utility of this framework was explored during an analogue Living Lab in Brussels and feedback was provided from consortium stakeholders in a subsequent consortium meeting. That workshop's feedback, translated into an applied model, is captured in Fig. 2 below:

Fig. 2 develops the CS loop (Steps 1–3 in Fig. 1) in greater detail, based on the experiences gathered from consortium stakeholders. In a preparatory phase a facilitator ('Provider') interacts with the users ('The People'/'Utilisers'), leading to the submission of proposals which are shaped and voted upon in direct interaction between the users and the platform. The selected socio-spatial configurations (proposals) proceed to the crowdfunding phase (Steps 4,5,6 in Fig. 1).

Drawing from the discussions in Section 2.2, Fig. 3 further refines the abstract concepts in Fig. 1, to show how management, design and planning can be read as the network of relationships between classes of actors "◊" and the socio-technical configurations "○" they affect or transform during the Incubators process., are influenced by variety reduction filters, identified with the symbol **Ø,** and happen in different environments "□". These are:

- Real-life workshops
- The web platform (https://incubators-london.neurovation.net/) and, nested in it,
- The 3D semantic modelling tool

The diagram describing the system outlined so far takes the shape of a flow chart, where the transition from the existing socio-spatial configuration to the final implemented result (and its perception) happens through a sequence of analysis, crowdsourcing and crowdfunding steps, shaped by the inputs of different users and stakeholders.

The framework also captures the role of technical experts, showing both their role of initiator as well as of engager, facilitator and designer throughout the process. The framework was flexible and adaptable to the Turin, Brussels and London case studies. By applying variety reduction on the framework itself, we achieved a level of abstraction

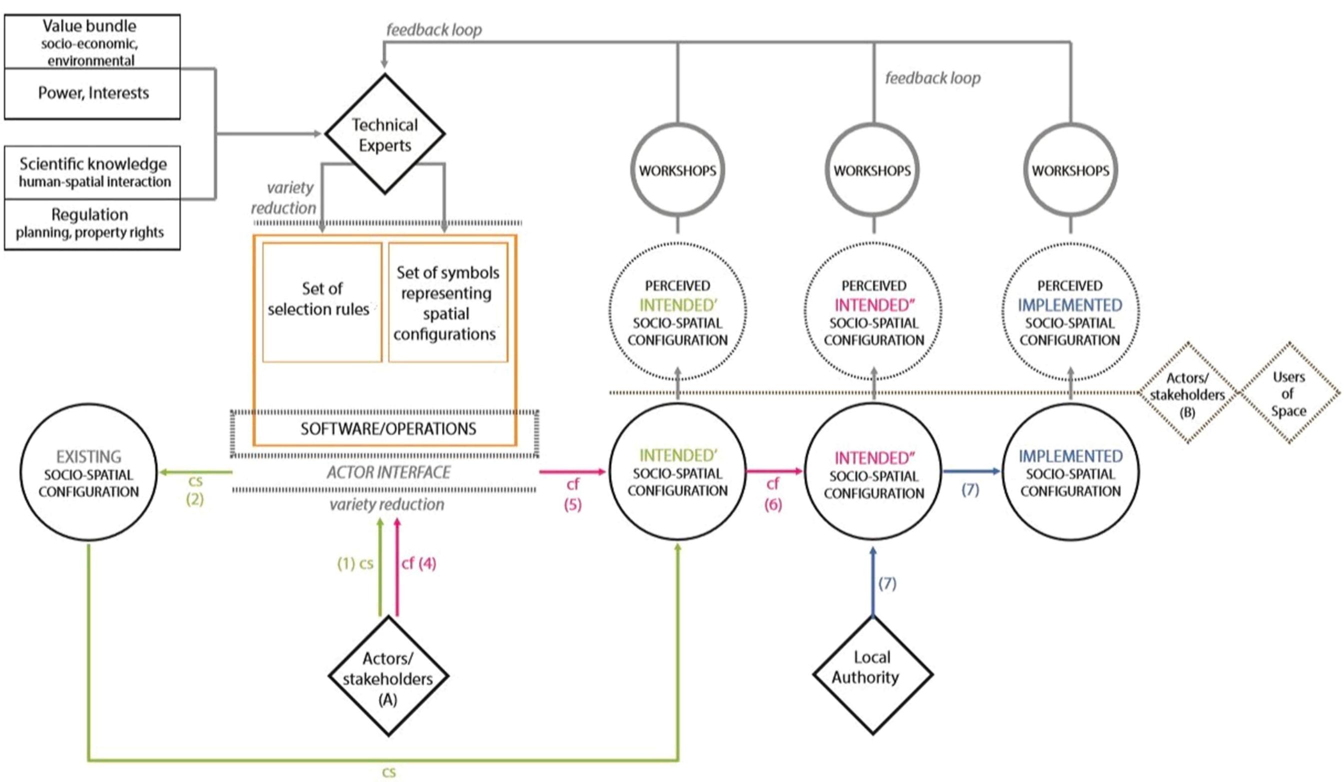

Fig. 1. Process design: relationships, concepts and procedures.

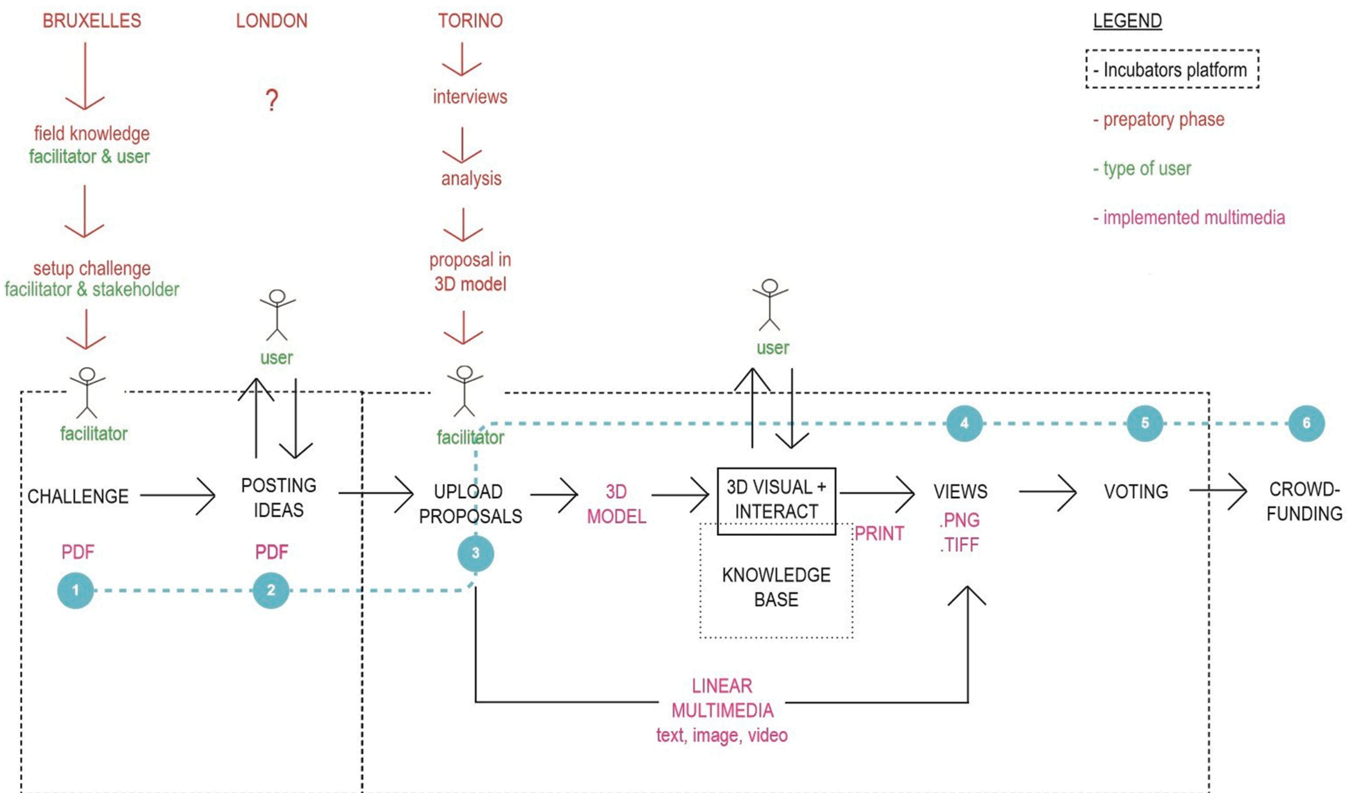

Fig. 2. Applied framework model, following stakeholder feedback on the process design.

that makes the diagram specific to the Incubators process but not affected by case-by-case differences, such as, the number of actors or the scale that symbols refer to in the semantic modelling tool.

4. The London case study: Pollard's Hill

4.1. Context

The Pollards Hill housing estate is located in the borough of Merton, south London. The estate was built in 1968–1971, comprising low-rise high density dwellings featuring three story terrace houses in a distinctive 'Greek key' formation, set around public 'courtyards'. Donnelly Green provided a recreation space and children's play area. The estate also includes a library and community centre (Fig. 4a,b).

The tenants of the estate are a socially and ethnically diverse group. Many of them have exercised the right to buy and for this reason there is a mix of homeowners and social housing tenants. MOAT, the organisation who owns and manages the social housing units, have a local office at the edge of the site, which serves as a point for information exchange of various kinds. They are actively engaged in many local community activities and are aiming to boost community engagement and participation in general, with good links to local schools and employers and community groups.

The project team became aware of some issues in the area (actual and perceived; some via MOAT and some via public media) although when visiting the site there was rarely any direct evidence of crime or antisocial behaviour. There are public alleyways between courtyards and closes that typically have staggered ('dog-leg') layouts with perpendicular changes in direction, meaning one cannot see the exit from the entrance.

Specific issues learned of by the researcher team were residents' concerns that the courtyards were too often just used for dog fouling; that the courtyards might better be kept as peaceful places rather than attractors of activity and noise; that they might therefore be usefully be made *less* accessible or less 'permeable', which might improve security; and a concern that any newly added facilities might be damaged.

Additionally, the courtyards are in need of physical refurbishment, including remedial work on the ground conditions, as some of the courtyards get boggy in wet weather. At the time that the research was carried out, the estate was undergoing a £ 35 million regeneration, involving extensive refurbishment of over 400 homes. A future phase would feature new housing blocks and improvements to green spaces and the estate layout.

4.2. Platform trial

At the time that the project team became involved at Pollards Hill, the first set of closes had already been refurbished including repainting, and a consultation on ideas for courtyard redesign was in preparation. The estate regeneration was a complex process comprising simultaneous overlapping phases of refurbishment for successive courtyards. Each courtyard intervention would go through a round of initial consultations on possible designs, whose outputs would be used by the landscape architects to draft preliminary designs. These designs would go through another round of consultation prior to construction.

4.2.1. Choosing a colour for the courtyards and closes

One of the initiatives foreseen in the regeneration programme was the repainting of all closes and courtyards in colour palettes to be chosen in consultation with the residents. The only limitation to people's choices (other than the palette itself) was that two courts adjacent to each other could not have the same colour. At the time the research team engaged with the process, a simple colour palette voting form had already been used during the first (analogue) voting for Monmouth Close. This combination of a colour palette and a rule for selecting a colour from it, significantly reduced the possible future states of the system (ie the colour configurations of all closes and courtyards) thus making the consultation process comprehensible to participants an

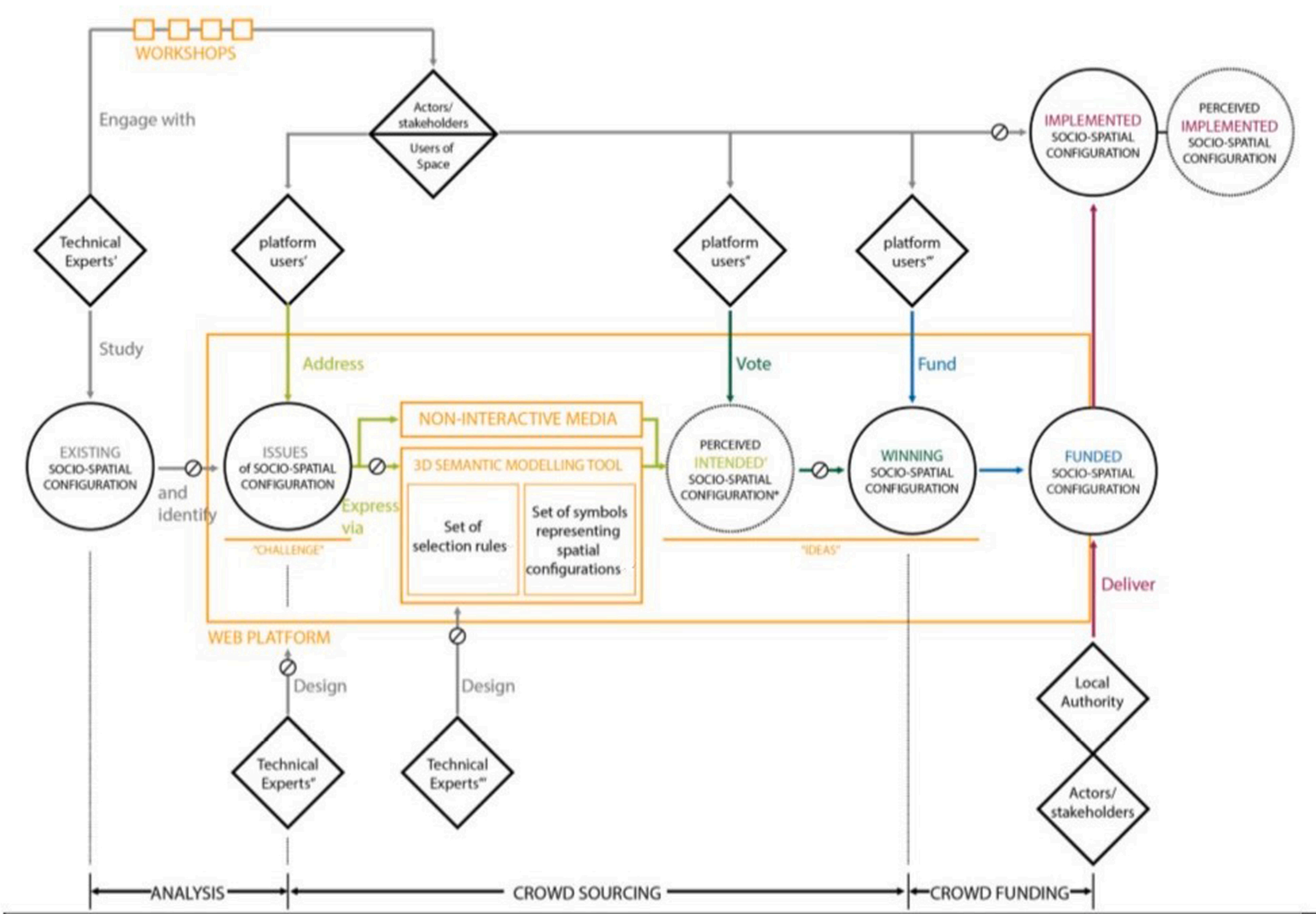

Fig. 3. Place-making flow chart using Crowdsourcing and Crowdfunding.

experts alike. So much so that the process could easily be managed in analogue format.

The research team used the colour voting as an opportunity for piloting the platform and for introducing the residents to its use. The key issues that arose during the piloting stage have been analysed in length in Timmerman et.al. (2019), in short they where:

1) To decide who would get a vote ie the constituency for each close and courtyard;
2) To limit voting to one vote per household ie prevent households from opening multiple accounts per household and prevent multiple household members from using the same account;
3) To tackle differences in how colours show on screen and on paper;
4) To adjust the colour choices available to each close taking into account the voting results from other courtyards' voting.

Although these were not technically difficult issues to resolve, their proposed solutions showed the limitations of crowdsourcing platforms. For example, there were no savings to be made when issuing letters with security certificates as opposed to sending a paper voting slip to each household unless of course these certificates were to be used for other purposes too from then on. In addition, as there were households which would refuse or would be unable to use the platform, a paper voting slip would in any case have to be sent to every household, thus creating a dual system. This made vote counting a bit more complicated compared to an entirely analogue or entirely online system. Finally, simultaneous voting by many constituencies was effectively incompatible with the design concept of no adjacent closes having the same colour, which requires sequential voting in order to be applied. Given that households would have to be sent a paper vote anyway and simultaneous voting was not possible, there were minimal time savings offered by online crowdsourcing compared to analogue consultation.

When faced with these hard realities, the research team and MOAT decided not to proceed with any further development of the platform for the purposes of colour selection, as it would require significant investment and would likely increase complexity without any obvious benefit for a time-sensitive process like this.

4.3. Creating the Incubators platform website

The London research team fed the lessons learned from the colour voting scheme into the Incubators platform design process. The Incubators platform was to be used for the redesign of the courtyards, a task involving a wide range of interventions of different kinds, for which input could be received in various formats: from suggestions in online discussions and fora to feedback, and eventually voting, on ideas which would be put forward as part of a formal design process.

In addition to the technical details of setting up user accounts and managing the vote, the issue of who should get the right to vote, resurfaced here with greater intensity as it was thought that many courtyard users would be under the age of 18, interventions would affect property values as well as resident wellbeing (so should the property owner or the tenant get to vote?).

Other considerations had to do with fundamental issues around democracy (see Timmerman et.al, 2019) for example: although courtyards could be identified as potential 'constituencies' whose 'votes' or preferences could be aggregated, it was not straightforward to settle the questions whether and how (and why) the residents of different

a

b

Fig. 4. (a) General view of a courtyard, Pollards Hill. (b) Pollards Hill master plan
(Source: Richard Timmerman).

courtyards might be enabled to vote for what happens in other courtyards.

As there was no rule to force differentiation between the choices made in different courtyards, it was entirely possible to have replication of preferences at the macro scale via majority voting at the local scale. Therefore, it would be entirely feasible for each courtyard to favour the same facilities and solutions as every other, but under-providing the estate in facilities which might be useful or necessary for the function of the estate but are less favoured by residents.

The Incubators platform required to first provide the user with some information about the site and the courtyard redesign, or more specifically, the context for the crowdsourcing system that residents were then to participate in. In early versions of development, it was imagined that there would be a public site explaining the whole context of Pollards Hill, the regeneration proposal opportunity and the Incubators project. However, ultimately it was felt that this public front would be effectively an additional layer of orientation that would add further and unnecessary complication to an already complex system; effort would be sunk into crafting parts of a site that could end up ultimately a distraction to the intended core users. Therefore, after an initial developmental period it was decided that the site would only be oriented to the residents (and other trial users) who would be actually taking part in the process. This allowed a more single-minded focus on taking the user to the action as easily as possible.

There were still decisions to be taken about whether a prospective user had first to obtain or create a user account even before they could enter the site, or whether there would be an informative 'landing page' with some information to help inform and so encourage the resident to participate, before facing the potential barrier of usernames and passwords (Fig. 5).

The whole website also had to be carefully tailored to the needs of the residents, avoiding wherever possible the use of too technical or academic language; to be written in an encouraging, engaging manner. Relieved of the need to contextualise Pollards Hill, the website then could rather directly present the business of what they were being asked to participate in – the so-called 'challenges' representing the initiative to redesign the courtyards (and, in the earlier prototype, these included separate 'challenges' for each courtyard, and including the 'challenge' of choosing paint colours). As part of this presentation, the opening pages of the platform showed some examples of recent proposals by users (see later, Fig. 6).

In the early stages, these were populated by trial designs by the project team and invited trial users – such as doctoral students interested in London housing, public participation and/or design technology. These were removed prior to public launch; although nevertheless the issue of using would-be 'exemplary' designs without any filtering could also be an issue for live end users, in the case of producing less than exemplary or incomplete contributions.

4.4. *A platform for uploading ideas*

The Incubators system was then to devised to allow for users to make direct suggestions for proposals, in a variety of ways at a variety of levels. These are:

1. A simple text entry, allowing users to describe ideas for their courtyard(s) simply using ordinary language;
2. Image upload, allowing users to upload an image – such as a photo of some desired feature, or some exemplary location – to get across their idea(s) for their courtyard(s); augmented by a title or description as desired;
3. An online 'drawing board', allowing the user to create a dedicated image of their own, by various drawing tools, for example, allowing someone to sketch a solution that could not otherwise be replicated using existing photos;
4. The three-dimensional model, allowing the user to add interventions, from a pre-defined set of possible interventions, in an arrangement of their own choosing.

All four of these would be open to view, and comment and feedback by other users, and in principle, any other user could pick up on an idea, and extend or modify it further. For example, one could in principle download an image of a desired kind of feature or whole layout supplied by another user, and alter it; however this would imply using one's own software (as well as skills) to do so, in the case of (2), while the software of (3) and (4) is integral to the platform. The three-dimensional model is dealt with in more detail later. Here, we expand on the first three items.

1. *Text entry* – this is the simplest, quickest and easiest way to input user-specified material. As such, one might expect this to gain a relatively high proportion of all contributions. However, this was probably felt to be less engaging and less important at the test stage.
2. *Image upload* – this is also a relatively simple mechanism, akin to attaching a document to an email, and so readily familiar to most people familiar with using the internet. Test users duly produced a series of ideas of varying degrees of seriousness and inventiveness (Fig. 6); it seems that this kind of mechanism would work in practice.

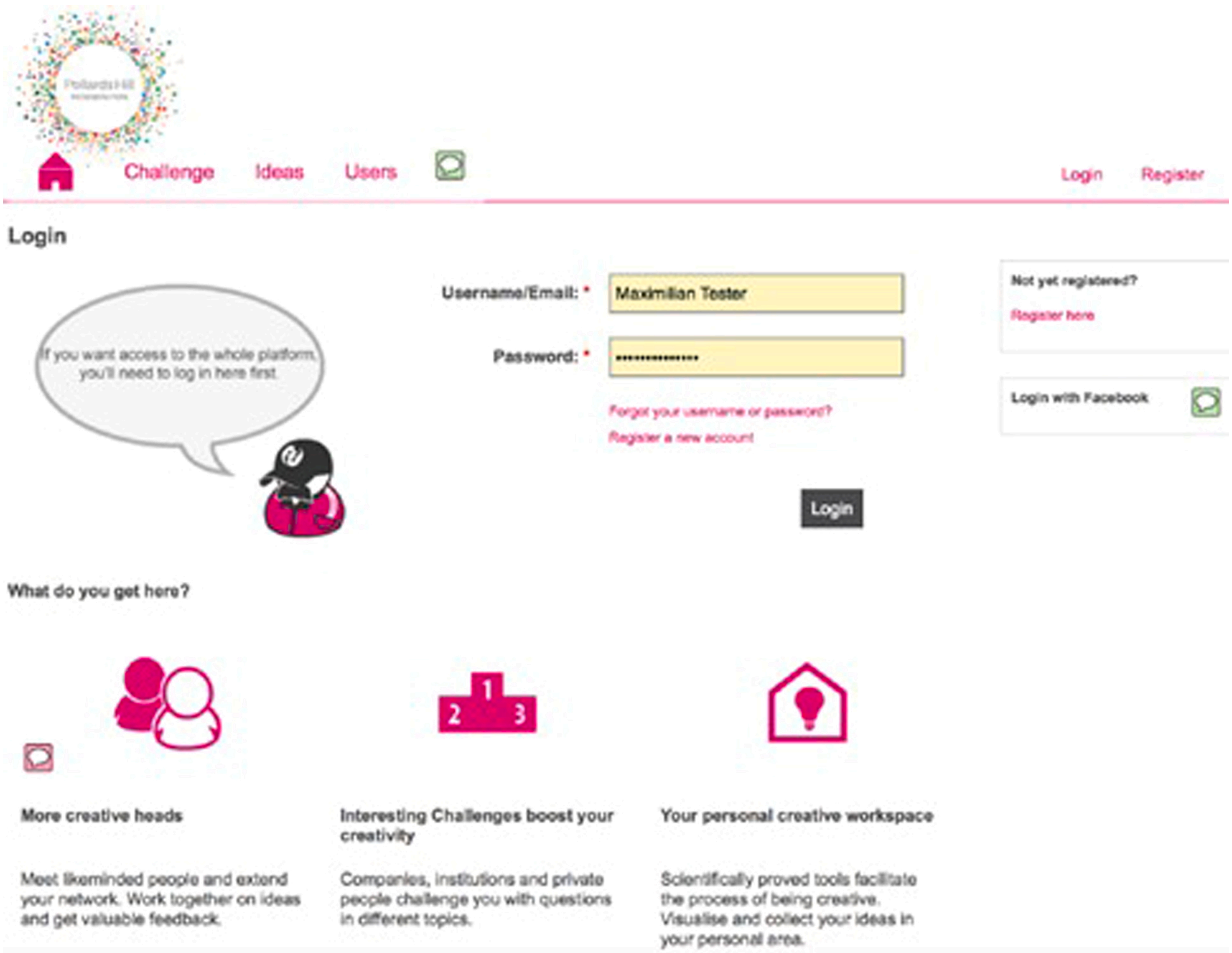

Fig. 5. Screenshot of the Incubators website login page.

3. *Online 'drawing board'* – On entering the drawing board, one is presented with a blank space, and a set of drawing tool options or menus. However, this software requires proactive initiative and a degree of creative drawing skill to fill the empty space. While most online users are likely to be familiar with text and image uploads, only a small proportion probably use software for drawing (as opposed to editing existing images). As it turned out, this tool was little employed by test users.

4.5. Devising the interventions for the 3D model

From an early stage in the development of the Incubators project, it was envisaged that the crowdsourcing platform would feature an interactive three-dimensional model to which users could adapt, adding things and moving them around, and 'flying through' the resulting proposal, and sharing it online for public display, feedback and onward development. As the project developed, certain other factors firmed up, certainly in the case of Pollards Hill:

(i) the design would be based on a fixed set of existing infrastructure (the buildings, fences and paths constituting the perimeters of the courtyards); removing or altering buildings or boundary fences, or closing off alleyways, or converting public space into private space, etc. would not be possible. This limitation was an effective means of design variety reduction which firmed up the scope of the entire exercise, and managed everyone's expectations in light of stakeholder design capacity and property rights restrictions.

(ii) the design remit would involve choosing from an extensive but ultimately limited set of plausible, allowable interventions, of various kinds (landscaping; infrastructure; sports equipment, etc.); again, a useful means of variety reduction.

(iii) the design elements enabled inclusion of an indicative cost, but cost was not going to be an explicit or decisive part of the 'challenge' in this case (i.e. ideas would not be promoted or discouraged on grounds of cost); however, it was assumed that participants would understand that, implicitly, the costlier proposals would be less likely to find favour, or might not be able to be implemented as extensively as others.

Furthermore, by the time of public release, it had become clear that it would only be possible to use the original base model of one of the courtyards, rather than separately modelling each of the seven courtyards. While the differences between the courtyards are in some senses modest, especially to an outsider, meaning that there was not much going to be practically different in how a designer in the abstract might treat each courtyard, nevertheless in principle, it would be interesting to have seen how different sets of residents might have approached their own courtyards, potentially giving rise to a welcome and possibly unexpected diversity, overwriting the original underlying uniformity.

Additionally, there is arguably a meaningful 'psychological'

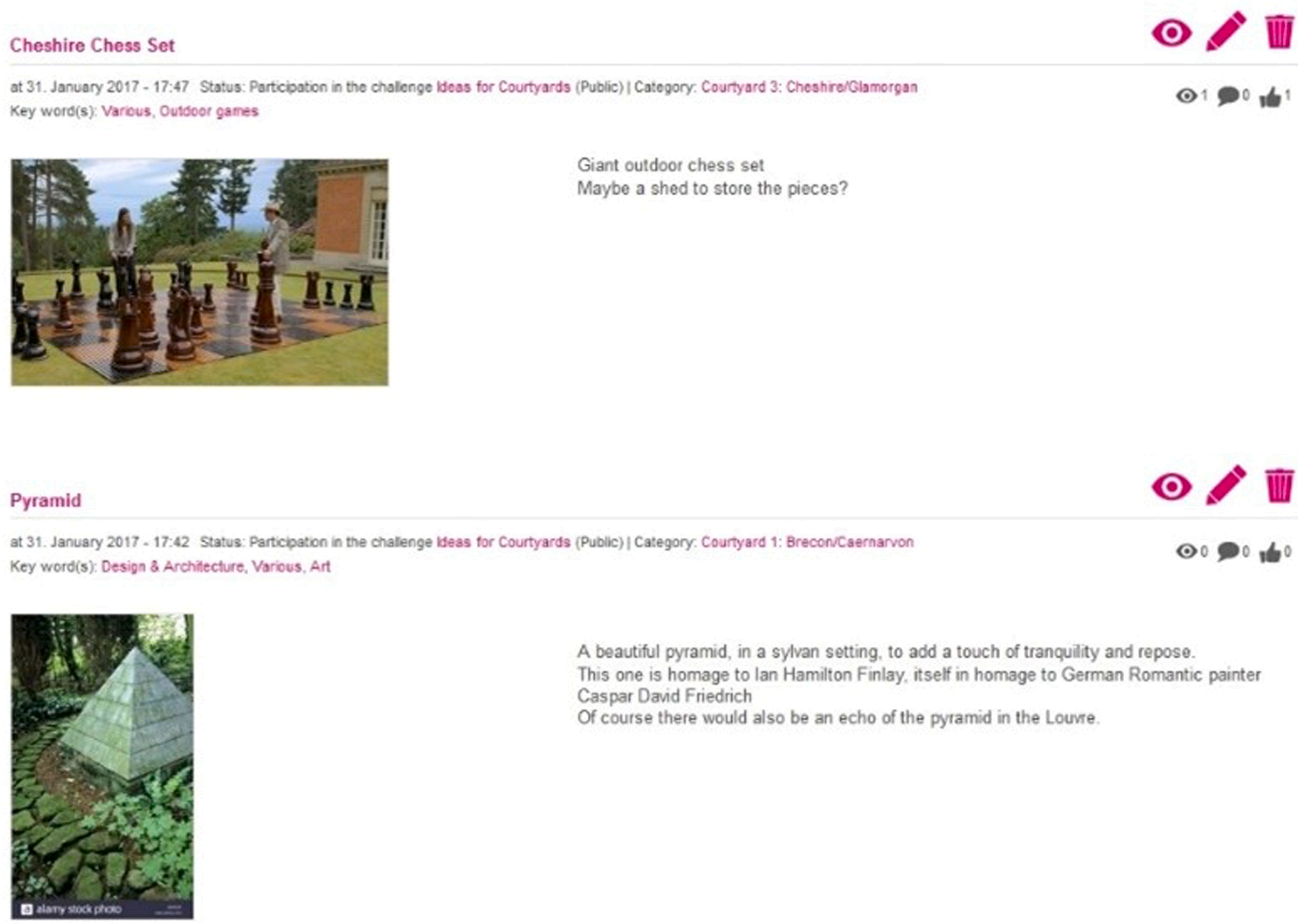

Fig. 6. Detail of some of the ideas generated at the test stage.

difference between a resident being asked to suggest proposals for a generic courtyard and their own particular one (even if these are physically similar). Be that as it may, the practical result of this was that it was possible to considerably reduce the complexity of the 'offer' to residents – focusing on a single generic courtyard rather than a system of dividing and directing residents into different design 'destinations', and further simplifying the issue of who would be creating for, commenting on, or voting on, what and where – all with *relatively* little practical loss to the nature of the design exercise.

Here, it will suffice to note that, in comparison with the other three kinds of intervention discussed earlier, the 3D model could be seen as intermediate in character. On the one hand, it required a more committed willingness to grasp the new software – which is not only more technically sophisticated than a basic 2D drawing package, working in three dimensions and tools for tilt, pan, zoom and so on – but a commitment to a literally bespoke designed software package, albeit one devised for this particular site, the commitment being therefore mutual. On the other hand, this software, once getting the hang of it, requires less open-ended creativity than the drawing board, and indeed ideas expressed through existing images or text (which can of course imagine many more kinds of utopian intervention that adding trees or seating). This limitation can, of course, be seen as a strength, from the point of view of matching what are conventionally understood to be residents' realistic expectations. It could also be seen as a benefit by the housing management company, who does not wish to unduly raise expectations; although it could rule out the importation of perfectly credible ideas that work elsewhere, but which may not have occurred to the locals to propose.

One final note here to mention is that the design interventions employed in the model were deliberately devised to 'look generic'. In other words, if the benches appears to be boringly unadorned and undifferentiated, the sports facilities style-free and the trees of indistinct species, it is not because limitations of the resolution of the models (or the imaginations of the modellers) but a deliberate element of flexibility, that allow the expression of a general nature by the user ('some trees over here; a water feature over there') rather than the users becoming preoccupied by the particular kinds of trees or configurations or pools and boulders, which may need specialist designers (landscape architects, engineers, and so on), to deliver in detail, including any regulatory or contractual compliance. This draws attention to the fact that the designs uploaded into the system are intended as being indicative, for informing a future design by professional designers, rather than being outline blueprints to be faithfully articulated and realised.

4.6. Live implementation

The Incubators platform ran 'live' for seven weeks from 11th August to the end of September 2017. In addition to local residents, pupils from a local secondary school were invited to participate in a workshop trialling the platform, conducted on school premises, at which project researchers were present, to help provide context and guidance. This allowed the project team to reach a relatively large number of potential users in a single sitting. The Incubators system was also trialled by a small number of interviewees – representing practising practitioners - who gave more in-depth discursive feedback on the system.

(a) Overall, there were 74 users of the platform, generating 143 courtyard designs, examples of which are shown in Fig. 7. The project team received useful direct feedback from the school users and interviewees (these groups in the end made up the majority of the users). As far as we could tell, the users were well engaged with the software, generally finding the design challenge as being interesting, and the software having reasonable ease of use, although in some cases operation was judged to be a bit 'clunky'. Put another way, it seemed that the format of the design challenge, and the use of tools for selecting and deploying

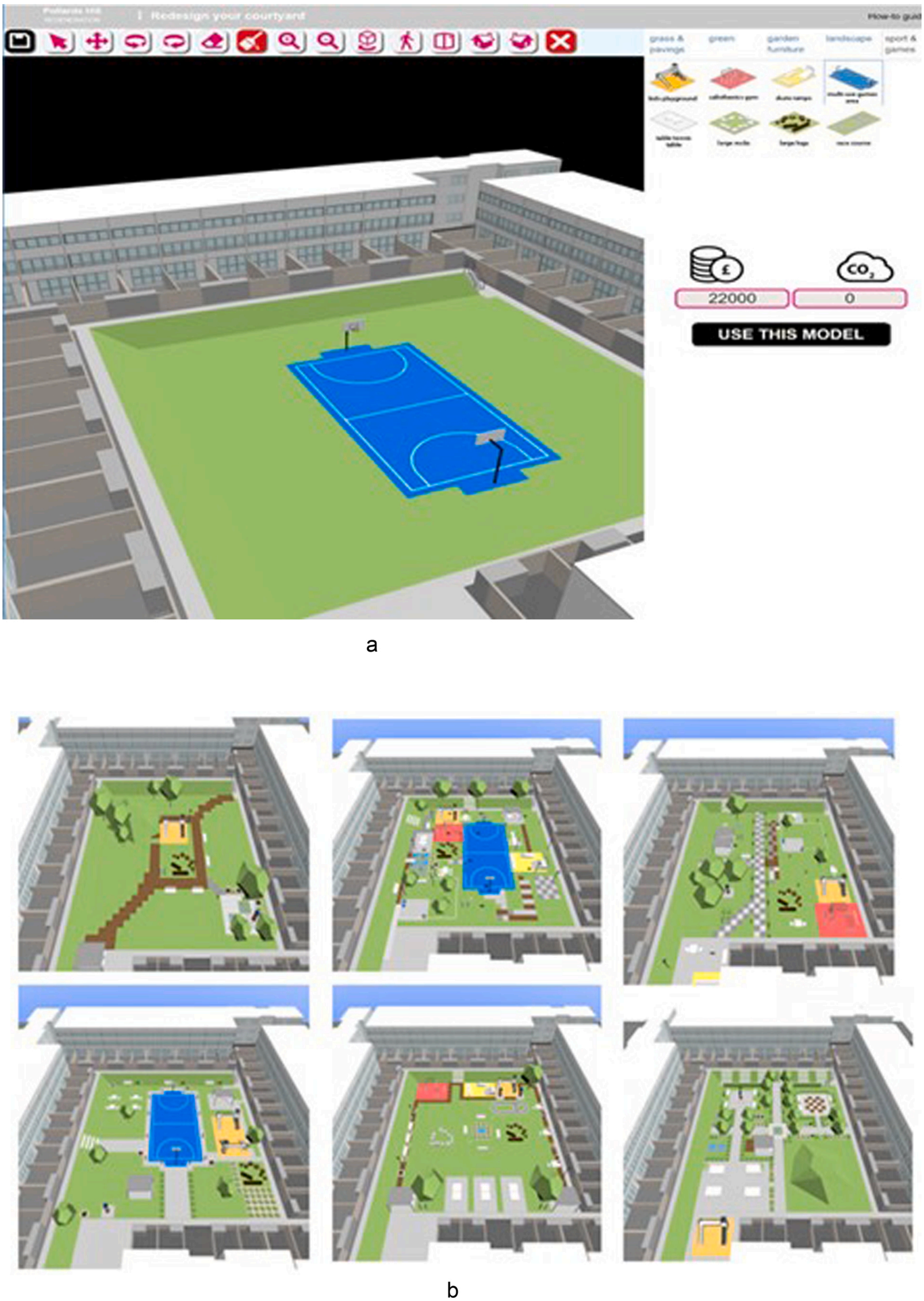

Fig. 7. Screenshots of the Incubators platform in use. (a) General view showing menu options for action (top) and design components (top right). (b) A selection of designs generated by the users.

different design features, to create individual designs, and the ability to 'fly through' or view the design, could be considered were successful; while the limitations in the running of the software itself, including the agility relating to the response times of using some of the controls, could be remedied in a future version. The experience of the school workshop also gave insights in the potential role for such platforms to assist in educating young people about the design of the local environment.

5. Conclusions

The experience of creating and testing a crowdsourcing platform for the purpose of place making yielded many interesting results.

The experiment described in this paper confirms Malone's (2010) recommended principles and confirms the risks identified by Zogaj et. al. (2014). During the course of the research, it became evident to the researchers that a Crowdsourcing platform has the potential to marginalise social groups and especially those who are less familiar with or have no access to a computer and the internet (ie the elderly and the poor). Depending on the level of sophistication of the input mechanism, an incubator of public spaces could also marginalise those with less developed visual and graphics skills (or put those with more developed such skills ie the young in an advantageous position so far as the communication and application of their ideas is concerned.

In the case of Pollard's Hill, resident participation was relatively limited (as witnessed in previous research too), which compounded the inherent marginalisation dynamic of the CS idea. As highlighted by the colour voting trial, the effort to address those limitations effectively nullified the supposed cost and time efficiencies digital crowdsourcing was supposed to offer when compared to analogue consultation methods. Decisions about who gets the right to vote and why, could also lead to marginalisation of social groups of course, and the research has identified that these decisions do not necessarily have an obvious answer but do have cost implications, depending on the nature of the decisions taken.

What is more, the research showed how important structural limitations are to the operation of a CS platform: a simple colour application rule which serves a design purpose was perfectly suited to an analogue operation of the consultation process but short-circuited the digitised version of it. It emerges that the resources allocated to a dedicated CS platform are only worthwhile if elements of this platform (for example the credentials) are to be used repeatedly in the future. Offering digital credentials to the population, in a way that covers every citizen of the country, could therefore yield significant results in terms of making the digitisation of the economy and society more cost-efficient. While this research focused on the application of accessible 3D-modelling to improve on planning consultation events, with the intention of broadening the demographic of participants, its potential to generate substantial amounts of data is also acknowledged. Feedback in the form of votes and comments on designs presents opportunities for global feedback, where subsequent analyses relating to geographic locations, and relative urban features, presents an opportunity for further research. However, during this experiment, the scope of the participants was limited to residents and users of the courtyards.

Last, but not least, the experiment utilised variety control in a place-making CS process in order to make it manageable. Notwithstanding the expectations heaped on CS's advantages for creativity and local democracy, the issue remains that variety reduction may make the CS process manageable for all stakeholders but may well lead to poor design outcomes in the form of macro-scale homogeneity enforced by digitised NIMBY-ism.

This last point is particularly relevant to policy makers. As discussed in Section 1, a lot of hopes have been pinned on CS and CF in order to resolve the technical and political problems associated with public participation in the process of spatial transformation. Our project aligns with previous findings reported in the literature that although crowdsourcing has a lot of potential to efficiently increase participation and could potentially lead to more effective outputs, neither of the two outcomes is guaranteed. Insights from the application of cybernetics to the creation and operation of a CS platform shows that we need to be aware of the inherent structural limitations of the design of the process and of the medium (ie the digital platform) itself. These are by no means neutral but seriously affected by expert inputs (and biases), the variety control decisions made by those experts, the existence of population-wide digital credentials and the pre-existing political and social capital dynamics of a community. In that sense, achieving Dahl's characteristics (Dahl, 1982), as outlined in Section 2.2 remain ideals which are hard to achieve but worth striving for.

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References

Alexander, C.,1964. A city is not a tree. Architectural Form 172 (April/May).
Arnstein, S.R., 1969. A ladder of citizen participation. J. Am. Inst. Plan. 35 (4), 216–224.
Ashby, W.R., 1956. An Introduction To Cybernetics. An Introduction To Cybernetics. Chapman & Hall, London.
Bailey, P. , 2014. Helena Bonham Carter and the case of the failed city crowdfunding experiment, the Guardian Cities, available from ⟨http://www.theguardian.com/cities/2014/apr/28/failed-citycrowdfunding-urban-projects-helena-bonham-carter⟩.
Batty, M. , Lin, W. , 2022. A Digital Future for Planning: Spatial Planning Reimagined Issued: February 2022 ISBN: 978–1-9162056–2-8.
Batty, M., Dodge, M., Jiang, B., Hudson-Smith, A. , 2000. New technologies for urban designers: the VENUE project, Centre for Advanced Spatial Analysis Working Paper Series 21. University College London.
Beer, S., 1959. What has cybernetics to do with operational research? J. Oper. Res. Soc. 10, 1–21.
Bekkers, V., Homburg, V., 2007. The myths of e-government: looking beyond the assumptions of a new and better government. Inf. Soc. 23 (5), 373–382.
Blohm, I., Köroglu, O., Leimeister, J.M., Krcmar, H. , 2011. 'Absorptive capacity for open innovation communities-learnings from theory and practice', 2011 Academy of Management Annual Meeting.
Boyer, B. , Hill, D. , 2013. Brickstarter, Available from ⟨www.brickstarter.org/Brickstarter.pdf⟩.
Brabham, D., 2009. Crowdsourcing the Public Participation Process for Planning Projects. Planning Theory 8 (3), 242–262.
Brabham, D., 2012. The myth of amateur crowds: A critical discourse analysis of crowdsourcing coverage. Information, Communication & Society 15 (3), 394–410.
Brownill, S., Inch, A., 2019. Framing people and planning: 50 years of debate. Built Environ. 45 (1), 7–25.
Busarovs, A., 2013. Ethical aspects of crowdsourcing, or is it a modern form of exploitation? Int. J. Econ. Bus. Adm. 1 (1), 3–14.
Calhoun, C., 1998. The public good as a social and cultural project. In: Powell, W.W., Clemens, E.S. (Eds.), Private action and the public good. New Haven. Yale University Press, CT, pp. 20–35.
Ciaffi, D., 2019. Sharing the commons as a 'New Top' of Arnstein's ladder of participation. Built Environ. 45 (2), 162–172.
Clarke, K.C., 2003. 'The limits of simplicity: toward geocomputational honesty in urban modelling', *Proceedings of the Seventh International Conference on Geocomputation*, September 8 – 10, University of Southampton.
Dahl, R.A., 1982. Dilemmas of Pluralist Democracy: Autonomy Vs. Control, 31 ed. Yale University Press.
Davies, R., 2014. Civic crowdfunding: participatory communities, entrepreneurs and the political economy of place. SSRN Electron. J.
Evans-Cowley, J.S., 2010. Planning in the age of facebook: the role of social networking in planning processes. GeoJournal 75 (5), 407–420.
Future Cities Catapult , 2016. Crowdfunding: A Guidebook for Local Authorities. London: Future Cities Catapult.
Glanville, R., 1994. Variety in design. Systems Research 11 (3), 95–103.
Glanville, Ranulph ,1997. The Value of being Unmanageable: Variety and Creativity in CyberSpace In: Proceedings of the Conference "Global Village '97", Vienna.
Goodspeed, R., 2015. Smart cities: moving beyond urban cybernetics to tackle wicked problems. Camb. J. Reg., Econ. Soc. 8 (1), 79–92.

Grieves, Michael, 2015. Digital Twin: Manufacturing Excellence through Virtual Factory Replication.

Hasler, S., Chenal, J., Soutter, M., 2017. Digital tools as a means to foster inclusive, data-informed urban planning. Civ. Eng. Archit. 5 (6), 230–239. https://doi.org/10.13189/cea.2017.050605.

Healey, P., 1992. Planning through debate: the communicative turn in planning theory. Town Plan. Rev. 63 (2), 143–162.

Heikkinen, M.T., Mainela, T., Still, J., Tähtinen, J., 2007. Roles for managing in mobile service development nets. Ind. Mark. Manag. 36 (7), 909–925.

Hookway, B., 2014. Interface. MIT Press, Boston, MA.

Hoßfeld, T., Hirth, M., Tran-Gia, P., 2012. Crowdsourcing. Informatik-Spektrum 1–5.

Howe, J., 2006. 'The Rise of Crowdsourcing', *Wired*, 14(6), URL: 〈http://www.wired.com/wired/archive/14.06/crowds.html〉.

Howells, J., 2006. Intermediation and the role of intermediaries in innovation. Res. Policy 35 (5), 715–728.

Hudson-Smith, A. , 2015. 'Incubators of Public Spaces WP4 Virtual Prototype of the Incubators services: Initial suggestions for the London case.' Internally circulated document.

Irvin, R.A., Stanbury, J., 2004. Citizen participation in decision making: is it worth the effort? Public Adm. Rev. 64 (1), 55–65.

Jetzek, T., Avital, M., Bjørn-Andersen, N., 2012. 'The Value of Open Government Data: A Strategic Analysis Framework'. In *Proceedings of SIG eGovernment pre-ICIS Workshop*, Orlando, USA.

Karadimitriou, N., 2010. Cybernetic spatial planning: steering, managing or just letting go? In: Hillier, J., Healey, P. (Eds.), The Ashgate Research Companion to Planning Theory. Conceptual Challenges for Spatial Planning. Ashgate Pub. Co., pp. 425–446

Krek, A., 2005. 'Rational ignorance of the citizens in public participatory planning'. In *10th Symposium on information- and communication-technologies (ICT) in urban planning and spatial development and impacts of ICT on physical space, CORP 05*. Vienna University of Technology: Vienna.

Lane, M.B., 2005. Public participation in planning: an intellectual history. Aust. Geogr. 36 (3), 283–299.

Leimeister, J.M., Huber, M., Bretschneider, U., Krcmar, H., 2009. Leveraging crowdsourcing: activation-supporting components for IT-based ideas competition. J. Manag. Inf. Syst. 26 (1), 197–224.

Malone, T.W., Laubacher, R., Dellarocas, C., 2010. The collective intelligence genome. IEEE Eng. Manag. Rev. 38 (3), 38.

Manson, S., 2001. Simplifying complexity: a review of complexity theory. Geoforum 32 (3), 405–414.

McDougall, M., Beattie, R.S., 1998. The missing link? Understanding the relationship between individual and organisational learning. Int. J. Train. Dev. 2 (4), 288–299.

Natarajan, L. (ed.) , 2019. Outlooks on Participating: People, Plans and Places 1, *Built Environment*, 45(1).

Noveck, B.S., 2009. Wiki Government: How Technology Can Make Government Better, Democracy Stronger, and Citizens More Powerful. Brookings Institution Press, Washington DC.

Nyström, A.G., Leminen, S., Westerlund, M., Kortelainen, M., 2014. Actor roles and role patterns influencing innovation in living labs. Ind. Mark. Manag. 43 (3), 483–495.

Ostrom, E., 2005. 'Unlocking public entrepreneurship and public economies', *WIDER Discussion Papers, World Institute for Development Economics (UNUWIDER)*, No. 2005/01.

Ostrom, E., Gardner, R., Walker, J., 1994. Rules, Games, and Common-Pool Resources. University of Michigan Press, Ann Arbor.

Peck, J., 2012. Austerity Urbanism: American cities under extreme economy. City 16 (6), 626–655.

Pogrebinschi, T., Samuels, D., 2014. The impact of participatory democracy: evidence from Brazil's National Public Policy Conferences. Comp. Polit. 46 (3), 313–332.

Polletta, F., 2013. Participatory democracy in the newmillennium. Contemp. Sociol.: A J. Rev. 42 (1), 40–50.

Rayna, T., Striukova, L., 2010. Large-scale open innovation: open source vs. patent pools. Int. J. Technol. Manag. 52 (3/4), 477–496.

Rembeck, B., 2014. *Recapture the Civic: Citizen Participation in Crowdfunding Public Space*, MSc City Design and Social Science dissertation. London: LSE.

Roberts, N., 2004. *Public deliberation in an age of direct citizen participation*, American Review of Public Administration, 34 (4), pp. 315–353.

Saad-Sulonen, J., 2012. The role of the creation and sharing of digital media content in participatory e-planning. Int. J. E-Plan. Res. 1 (2), 1–22.

Sandmeier, S., 2011. Modelling plans and planning models: the cybernetic vision of a Swiss Integral Concept for Transport (1972-1977). Plan. Perspect. 26 (1), 3–27.

Schattschneider, E.E., 1963. The Semi-Sovereign People: A Realist View of Democracy in America. Holt, Rinehart and Winston, New York.

Seifert, J., Peterson, E., 2002. The promise of all things E? Expectations and challenges of emergent electronic government. Perspectives on Global Development and Technology 1 (2), 193–212.

Seltzer, E., Mahmoudi, D., 2013. Citizen participation, open innovation, and crowdsourcing: challenges and opportunities for planning. Plan. Theory 28 (1), 3–18.

Timmerman, R., Marshall, S., Zhang, Y., 2019. Towards socially sustainable urban design: analysing actor-area relations linking micro-morphology and micro democracy. Int. J. Sustain. Dev. Plan. 14 (1), 20–30.

White, G., Zink, A., Codecá,L., Clarke, S. ,2021. A digital twin smart city for citizen feedback, Cities, Volume 110,2021, 103064, ISSN 0264–2751,

Zhao, Y., Zhu, Q., 2012. Evaluation on crowdsourcing research: current status and future direction. Inf. Syst. Front. Vol. April 2012.

Zogaj, S., Bretschneider, U., Leimeister, J.M., 2014. Managing crowdsourced software testing: a case study based insight on the challenges of a crowdsourcing intermediary. J. Bus. Econ. 84 (3), 375–405.