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How to involve inhabitants in urban design planning by using digital tools? An overview on a state of the art, key challenges and promising approaches

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Abstract

Different cases of public disagreement in different European countries have shown recently that perusing a thorough planning process is by no means a guarantee for a broad public acceptance of an envisioned urban project. Consequently, the employment of digital media and tools to enable participation of inhabitants in urban planning processes on a massive scale is a promising, but currently not comprehensively analyzed approach. Our research activities are intended to gain an overview on a state of the art of research on communication channels, methods and best practices as well as to identify key challenges and promising strategies and tools to overcome these challenges with specific regards to large numbers of users and digital supported approaches. The latter aspects comprise the investigation of phenomena like participant selection, framing effects and gamified approaches for digital-mediated participatory processes as well as native language processing techniques to examine opinions as well as ideas of relevance from massive public feedback. To examine, we performed literature reviews of several hundred research articles, investigated cases in Germany, France and the Netherlands by interviews and workshops with stakeholders and employed methods of prototyping to conceptualize, develop and assess some promising approaches such as sentiment analysis in detail.

Keywords: urban planning, survey, public participation, state of the art

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1. Introduction

Different cases of public disagreement in different European countries have shown recently that perusing a thorough planning process is by no means a guarantee for a broad public acceptance of an envisioned urban project. Currently existing measures to inform the public and collect potential disagreement are based on classical media and require to lookup plans and project descriptions during the opening hours of municipal offices where those materials are at display. As seen for several recent planning cases overrun by public disagreement such as Stuttgart 21 [cf. 1], the 3rd runway of the Heathrow airport [2] or the withdrawn Olympic games application of the city of Hamburg, this procedure becomes outmoded in the digital age. Also, a public debate on urban planning become increasingly confusing in terms of communication channels, principles and opinions [3]. A promising approach to overcome these problems is to actively involve inhabitants in public processes. During the last decades this idea got very popular in order to fertilize acceptance and to reduce scepticism of citizens towards decisions of publically high awareness [eg. 4, 5, 6]. Moreover, public involvement is often seen – but not undoubted - as medium to enhance a quality of decision making in these contexts especially in terms of the provision of lay knowledge and locally adjusted solutions [7, 8]. How to involve inhabitants in urban design planning? According to Bryson [9] a major prerequisite to set up a successful participative process is to carefully assess and design for an intended context and purpose. Most large scale-projects have official project websites and employ social media channels like Facebook and Twitter, and so do initiatives against planning projects [eg. 3]. Consequently, the employment of digital media and tools to enable participation of inhabitants in urban planning processes on a massive scale is a promising, but currently not comprehensively analyzed approach. Since our research will base the development of a digitally enhanced platform for participatory planning support [10], this article is dedicated to gain an overview on (a) a state of the art for communication channels, methods and best practices, (b) key challenges and (c) promising approaches to overcome these challenges with specific regards to digital supported approaches.

2. Research Design

Within our research, we performed three stages of investigation: A literature review focussed on the examination of a current state of research. To gain practical grounded knowledge on current challenges and strategies to cope with large scale complex urban planning projects we investigated cases in Germany, France and the Netherlands by interviews and workshops with stakeholders. Finally, we employed methods of prototyping to conceptualize, develop and assess some promising approaches such as sentiment analysis.

Stage 1: Literature Review

Since there is much research on public participation in urban and architectural planning, our methodical approach is to review and classify existing literature to examine basic principles and key insights and gain implications for the design of the targeted platform. From a methodical point of view a literature review is "a systematic search of published work to find out what is already known about the intended research topic" [11, p. 58], to provide „an informed evaluation of that literature" [12]. A literature review is a relatively low standardized method and relies on stages of data search and critical evaluation [13]. Within our study the purpose of the review is to "familiarise the researcher with the latest developments in the area of research" and „study the definitions used in previous works as well as the characteristics of the populations investigated, with the aim of adopting them for the new research" [14, p. 20].

Stage 2: Case research

Case study research is a qualitative research paradigm to investigate complex phenomena [15]. To gain grounded insight in challenges and strategies unveiled during former participatory processes an in-depth study was performed on specific cases in Germany, France and the Netherlands. These cases were selected for their characteristics, which make them clear target project examples for the designated platform: large-scale, complex, dynamic, politically sensitive and involving huge numbers of stakeholders. For each case a white variety of qualitative data was retrieved, e.g. interviews with project leaders and other stakeholders; analysis of the written reports on the cases; analysis of the communication channels; and observations during case workshops organized for the public. Finally, the

cases were compared in order to identify similarities and differences, which led to a list of challenges that most of such large-scale projects face regarding participatory planning, co-creation and communication.

Stage 3: Prototypes

Prototyping is an established method especially in engineering to (re-)search solutions "by doing", to build common ground for communication as well as enable rapid testing [16]. Prototyping includes alternating stages of conception, development and testing. Within our research we use prototyping methods to fortify and assess promising approaches to fertilize public participation. While a software prototype for sentiment analysis is yet to be tested, the conceptual design of further prototypes are referred to in paragraph 4.4 and in [17].

3. State of the art on a methodology for participation in urban planning

A first stage is dedicated to examine a state of the art on participative urban planning. This comprises in particular a review of communication channels, existing methods for participation and digital supported approaches.

3.1. A participative urban planning process

How does a process of urban planning typically take place? And how to enhance that process by employing mechanisms of public participation? To investigate these issues we researched 61 articles on urban planning and participation [cf. 10]. Traditionally, urban design and development processes employ stages and phases as appropriate instruments to ensure successful design outcomes. Processes used to pass from pre-design analysis and briefings through design and planning phases to final execution (cf. Fig. 1).

Figure 1. Urban Design Process scheme

In the early phases, professional pre-design methods such as Programming [18] were used to collect and organize project relevant data, sometimes through structured formats of multiple stakeholders briefings and workshops. It has been argued this simple linear model is not at all the right way to solve real problems for the real world. In more recent studies, the process gets divided in multiple processes that run parallel and overlap, e.g. project management, information finding, content finding, acceptance finding [19]. Against that background, the key idea, however, is to involve end-users as early as possible in the overall process, and to maintain direct participation as far as possible [20]. Since user interactive and participatory planning approaches have been reported from many countries, including the United States [21], United Kingdom [22], Belgium [23], Scandinavia [24, 25] and the Netherlands [26], the methodology, as it was tested and elaborated in architectural and urban design practice, recommends to start with the involvement of a large number of end-users and to refine the generated information in smaller working groups with activists [27]. At later stages, when experts engage into communication with end-users to get feedback, the participation process will be again opened to a large number of respondents. A serious methodological problem is raised in regards to level of information, complexity, and security [28]. The lower levels are the public right to know, to be informed implying no involvement into the design process. Medium levels include participation in "defining interests and the agenda" and in assessing the risks and recommending solutions". The highest level of participation is reached when participation takes the form of "partnership in the final decision".

3.2. A state of the art on communication channels

Participatory planning activities (tools and methods) can be delivered through physical or virtual communication channels, or a combination of both. Figure 2 and Table 1 provide an overview of possibilities, which can be divided into 1-way and 2-way communication. 1-way communication does not allow for participatory planning activities,

since actual participation can only take place in interaction, thus 2-way. However, as the 1-way communication channels may be needed to reach the target audience in the first place and to inform them, they are included as well.

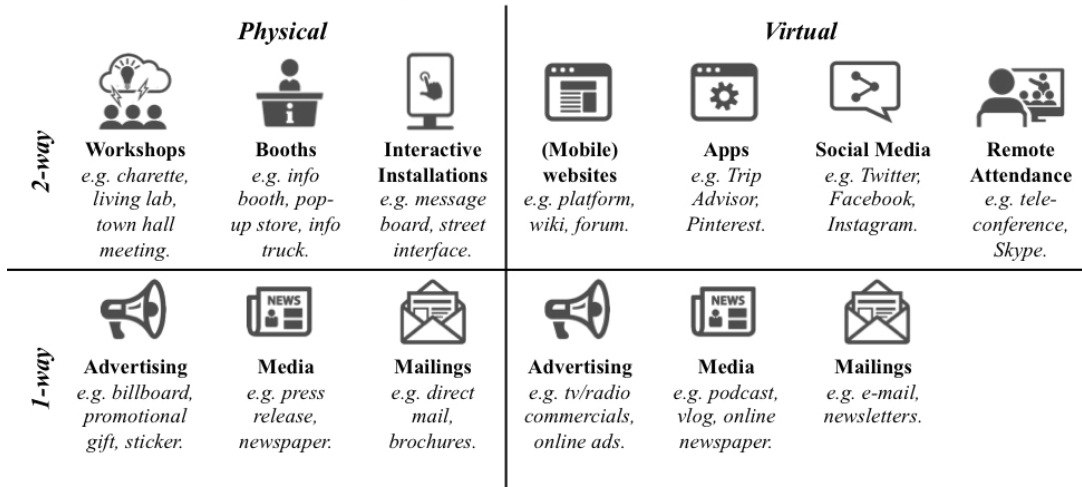**Examples of Communication Channels**

Figure 2. Overview of communication channels: physical, virtual, 1-way and 2-way

Table 1. Overview of parameters to consider when selecting the right communication channel(s) to fit the purpose of the specific participatory planning activity.

Parameter:	Short explanation:	Consider:	Ref:
Level of partici-pation	Arnstein's participation ladder describes five levels of participation and sets the role of participants (active or reactive).	- Informing, consulting, involving, collaborating or empowering	[29-31]
Level of partici-pant interaction	Participants can interact with each other in different compo-sitions.	- Individually, in pairs, in groups, or a progress through these types (me-we-us method) - Synchronous vs: asynchronous	[32-34]
Purpose of the procress stage	Different stages in the urban planning process require different mindsets and rules. E.g. the process of gathering opinions or obtaining ideas differs a lot from making deci-sions.	- Acceptance finding, content finding, infor-mation finding - Problem finding, idea finding, solution finding - Diverging, clustering, converging	[9, 35]
Reach	It is important to target audiences where the barriers to participate are minimized. The ease of participation also plays a large role.	- Home, public and transit spaces, project site, event centres/town halls, and online space - The access need of mobile devices - Time and effort to participate	[36-38]
Scalability	In addition to the reach, the question is how many partici-pants you want to reach. E.g. the facilitator/participant ratio in a face-to-face workshop is 1/8.	- 1-8 participants, 8-100 participants, 100-1000 participants, 1000+ participants	[35, 39, 40]
Participant selection	Closely linked to the previous two points is whether the reached participants represent the full range of opinions. See also paragraph 4.1	- Open to everyone (self-selection), stakeholder representative, demographically representative, or specific individuals	[9, 37, 40]
Participant skills	Consider whether the participants would need any training in order to participate through the channel.	- Initial/no participant training required	[41]
Cultural ap-plicability	Cultural background should be considered, since it relates to participants' social behaviour in certain settings e.g. related to power distance.	- Online readiness - People behaviour in open vs. anonymous setting	[37, 42-44]
Costs	Some channels are more expensive to operate than others.	- Costs per participant - Total costs for participatory planning activity	[45, 46]
Interaction quality and depth	Not all methods have the same interaction quality and depth.	- Delivering high vs. low personal contact and impact	[9, 47, 48]
Required labour and expertise	Linked to the previous two points: costs and interaction quality and depth. Some channels require little high-skilled labour, while others need e.g. a closely involved expert facilitator.	- Amount of labour and expertise necessary for configuration, engagement, involvement, utiliza-tion, analyzing, etc.	[46, 48]

Within each channel, there is a wide variety of tools and methods possible. For instance, "workshops" can range from serious gaming, to living labs, to generative sessions, etc. Each channel has its own opportunities and limitations. Therefore, it is important to deliberately choose the right channel(s) for the right purpose of the participatory process activity. To understand which parameters should be taken into consideration, an investigation on purposes of participatory planning was done which led to the set of parameters listed in table 1. For compiling this overview the general snowballing guidelines [49] were used. The overview is largely based on three meta-analyses from Involve [50], Bryson et al. [9] and Leighninger [48] and supplemented by additional public participation literature as well as design research literature. This overview may not yet be complete, but should be interpreted as a starting point for a higher purpose, which is developing a framework to support selecting the right participatory planning or co-creation tool(s) for a specific stage or situation in an urban planning project. However, this overview already shows that a lot of different combinations are possible in order to deliver the right participatory process and achieving the desired result. Since each situation requires specific types of communication channels, it makes sense that the different tools the planned platform should consist of will be using (a combination of) different communication channels. In addition, depending on the parameters described above, one can choose virtual or physical communication channels or a combination of both. It is likely that a combination of both will be used for an optimal experience and delivery of the participatory process. The strengths of physical (face-to-face) channels are the personal contact, the high interaction quality and depth and the possibility of utilizing non-verbal communication (e.g. body language). These components are very suitable for acceptance and consensus finding. These benefits come at the price of lower scalability, higher costs per participant and the need of more expert labour. The advantages of virtual methods are the high reach and scalability to involve and engage a large crowd, which could be very powerful in crowd sourcing tools and methods.

3.3. State of the art for methods

Citizens have a broad range of possibilities to communicate in urban planning like public hearings, neighbourhood meetings, community outreaches or citizen forums [51]. Since portals as Participedia.net [52] provide a general overview on methods for participation, our specific interest was to name methods specifically for urban planning. For the research of the tools, inter alia the used methods of 30 cities were extracted from multiple publications [eg. 53, 54, 55] which were written by the municipalities to proclaim their participation concept.

Figure 3. Layout of the participation method database

To organize these information within a database (cf. Fig. 3) a categorization into the level of participation as de-

scribed above took place, whereby the priority were consultation and collaboration methods. In addition, several other categories such as number of participants or length of the process were added. Currently the database includes over 70 methods. Only methods of informal participation are covered, because formal participation in urban development is precisely described in legal frameworks. Being associated to the EU H2020 project "U_CODE Urban Collective Design Environment", the database will be launched online within 2017 on the project website www.u-code.eu. The research shows that most cities only have a small number of methods, which they are used to and which are not too complex to undertake. Common methods are different low-level workshop formats, city walks or the handout of information material. More elaborate methods such as crowdsourcing platforms are seldom but growing. That means for future platforms that they should support the municipalities with knowhow and concrete instructions to assist the use of more customized methods. Most of the researched methods work offline (only 14 pure online methods), but many of the offline tools can be assisted by digital tools. A perfect example are passive displays (in contrast to interactive displays) which can provide way more information and address another target group via a displayed virtual reality. For future platforms, that means that they should support the use of sophisticated high-level technologies. If more complex methods result in a better outcome is yet to be examined.

3.4. Utilizing digital technologies for participation in urban planning

As mentioned in the described methods, only few formats are capable of managing larger participant numbers. A key concept to address the problem of limited reach is the combination of Information Technology, Human Computer Interaction and urban planning. In recent years, an increasing number of web platforms were developed to share information about spatial projects with local people and get to know their needs and knowledge [56]. For current planning cases like the Tempelhof Field in Berlin [57], the Reallabor for sustainable mobility culture in Stuttgart [58] or for different transit projects in the USA [59], city authorities have published online participation platforms. Online communities and discussion forums provide excellent participatory instruments to integrate expert knowledge and citizen commitment within decision making: "[In social networks and internet platforms] citizens can be easily involved in important decision making processes. […] And citizens themselves become active. In Blogs they discuss early on about projects. Even though facts may not be true, they still spread excessively fast. Emotions often escalate. Project developers and investors are well advised to recognise these channels and contribute to an objective discussion […] early on participation […] may counteract fears and prejudices of citizens." [47, p. 8]. Further opportunities for urban planning based on community engagement come from crowdsourcing, co-creative digital media, and neogeography tools [60]. So-called Expanded Participatory Design [61] "supports an expansion of the participatory e-planning locus towards collaborative work between experts and non-experts, anchored in mutual digital-media production and sharing" [61, p.25]. Saad-Sulonen highlights the difference between the collaborative approach and urban planning where planners "facilitate and orchestrate the deliberative activities". Also, participation tools in the format of "crowdsourcing platforms" have been established and come into use over the past years. Although there is still little research about their efficacy and methodology, social media-based contributions to open design spaces appear to be a most promising avenue also for urban planning, as online participatory design platforms like OWELA and RECORD suggest [62, 63].

3.5. Implications of digital participation technologies in urban planning

Digital participation technologies have the potential to thoroughly reshape the professional practice in urban design and development. It is necessary and most meaningful to enable constructive participation and co-design activities for the public in the early pre-design phases, when changes are still possible on a feasible basis [64]. Transparent ways for decision generation [eg. 50], procedural fairness and objectivity [eg. 65] and "win–win" solutions [eg. 66] are essential. Their impact can be summarized by four new qualities:

- *Crowdsourcing Knowledge*: Digital participation tools enable the utilisation of a wider knowledge basis as in conventional design practices before. It becomes possible to tap on valuable experiences and creativity of non-professionals too, especially local citizen experts.
- *Design Evidence*: New technologies like design sentiment analysis provide new evidence for designers and planners already in the design process. It is possible to develop projects in acknowledgement of public response, and to test public attitude and acceptance already in early project stages.

- *Interaction*: Besides technical advances, digital participation technologies provide for an interactive and communication-oriented planning process. Direct exchange between all stakeholders, especially planners and users (citizens, residents) will become a key activity in urban design.
- *Agile Design*: Participative tools and technologies will transform planning work into an iterative, agile work process, in contrast to sequential and linear workflows ("waterfalls") that have shaped urban design practice in the past.

4. Key challenges and promising approaches

What are major hurdles for participative planning processes and how to overcome? Former investigations on public participation [6, 9] identified various key challenges:

1. Few users: Especially publically initialized participative activities often lack a sufficient number of users. This may be caused by lacking information on the process [eg. 67, 68], barriers in culture, understanding or accessibility [eg. 69] or even weak motivation to participate [eg. 59].
2. Wrong users: As most participatory processes embrace everybody, they are faced with self-selection biases [70, p. 81]. As figured out in many studies, people willing to participate in urban planning processes rarely represent a majority of inhabitants or involve (potential) opinion leaders [eg. 50, 71].
3. Communication issues: Participators in public processes are influenced by many factors such as prior thoughts, feelings and beliefs [eg. 72], framing effects such as presentation formats and techniques or media channels [eg. 73], and their level of knowledge of the presented problem and the objectives to achieve. Another core problem is the communication of complex design issues to the public in the early project life cycle when concepts are still little shaped and hard to convey to non-specialists, but easy to influence and re-direct.
4. Process deficits: If a public participatory process lacks transparency, inclusion and fairness, or leads to publically felt poor decisions, it could cause more severe disagreement than if it never had taken place.

Studying these challenges and employing insights from the investigated cases these questions arise:

- *How to reach and engage a representative group of participants?* Most large-scale urban planning projects have a huge amount of stakeholders (citizens, interest groups, authorities, polititians, etc.). However, the stakeholders with the highest interest, power or will to participate, is most likely not a representative group of people who are affected by the project. For successful public participation it is key to provide an accurate representation of all possible opinions in the community, meaning a wide variety of people from different ages, cultures and social backgrounds. Especially when using digital tools, the digital readiness, accessibility and communication channels have to be considered and thoroughly analyzed. A promising approach to overcome these challenges - further discussed in paragraph 4.1 - is to employ multimodal approaches for participant selection, e.g. by combining online and offline tools.
- *How to engage and activate customers to participate in an early stage of the project?* Firstly*,* citizens do not care about projects until they start affecting them (e.g. 'not in my backyard'). However, with every project stage costs, commitments, and the level of elaboration increase, while risks, solution space, and thus the impact of activities on the project's outcome decrease. Secondly, the conclusions and decisions based on early participation may not be relevant anymore at project completion. Especially in our targeted (large scale) projects, urban planning projects can easily take 15+ years from the (problem) identification stage to realization. Meanwhile, citizens' needs and desires may have shifted. The use of gamification to fertilize user motivation is promising approach - further discussed in paragraph 4.2.
- *How to communicate a design project to make it understandable to the public and allow for collaboration?* To avoid misunderstandings, non-expert citizens should be able to understand the plans, even though they find it difficult to understand professional language, read plans or technical drawings, and are unaware of (technical or practical) constraints. Emerging digital tools like Virtual Reality, Augmented Reality and GeoLocation may be very helpful in bridging the communication gap between professionals and citizens - further discussed in paragraph 4.3.
- *How to facilitate participation and co-design with 10.000+ citizens?* Meeting and hearing 100 people during a face-to-face workshop was a challenge in one of the example cases. As the actual reach of digital

platforms can easily be 10.000+ people, how to make sure those people still feel heard and can make a significant contribution? Approaches from computer linguistics such as a sentiment analysis discussed in paragraph 4.4 are dedicated to make large scale user feedback feasible and ensure transparency between a public vote and suggestions for further planning.

4.1. Participant selection

One of the prominent theoretical and practical challenges in participatory urban planning is the non-representative participant selection [30, 74]. Current ways to organize public participation are:

1. Inviting participants representing stakeholder organizations [9]
2. Inviting all members of the relevant public by mail, papers, billboards, radio and television [9, 75]
3. Using online surveys to reach the complete relevant public [76]

As has been argued [9] the first way will lead to the phenomenon called "usual suspects" with obvious challenges. The last two have another challenge to cope with called "non-response bias" or "selection bias". The thread of "non- response bias" in traditional sample surveys is long known [see f.i. 77]. The higher the threshold for participation, the bigger the risk of "non-response". So mail surveys show an even lower "non-response" rate than participation meetings at city town halls [78]. "Non-response" leads to an increase in variance as a result of a reduction in the actual size of the sample and the recourse to imputation. This produces a bias if the non-respondents have characteristics of interest that are different from those of the respondents. Furthermore, there is a risk of significantly underestimating the sampling error, if imputed data are treated as though they were observed data [79, p.59]. Jüni and Matthias [80] describe a form of selection bias in their research called attrition (loss of participants). This form of selection bias involves dropout, non-response, withdrawal and protocol deviators. In their research, the example of a dieting test is mentioned. In this example, the researcher simply rejects everyone who drops out of the trial, when most of the ones who drop out are those for whom the treatment isn't working. We see the same effects happen in participation in urban planning. Concerning the third way, the phenomenon of self-selection bias leads to differences of up to 300% in results retrieved from a total population in contrast to self-recruiting partcipants in online surveys [81]. In literature three modern ways to overcome "selection bias" can be found:

1. Finding participants in relevant stakeholder organizations, but through opinion leaders [see f.i. 82]
2. Sampling by representation via random lotteries [76]
3. Sampling via indirect methods [83]

All three modern ways are promising avenues for preventing selection bias in public participation in urban planning. In our first round of prototyping [83], some first results were found in an online tool for public participation provided this online tool was used in combination with offline tools. It will need further research and prototyping to find a good mix of tools for public participation that will reflect the public opinion correctly without selection bias.

4.2. Gamified approaches for participation

Gamification as the "use of game design elements in non-game contexts" [84] provides mechanisms to enhance user motivation to participate and contribute to planning processes. In order to retrieve information on this subject, we performed a literature review including the databases EBSCOHost, ACM Digital Library and Scopus.

Table 2. *Categories of citizen participation in urban planning [85]*

Category	Information	Consultation	Collaboration
Description	Citizens inform or are being informed on recent or future plans, decisions and actions	Citizens are asked to give input and feedback (e.g. opinions, solutions)	Citizens and other stakeholders actively work together in decision-making
Relation	***One-way***	***Limited two-way***	***Advanced two-way***

Besides, by using the snowball principle, additional works were found that were not covered by the database-driven keyword search. As discussed in detail in [86], 188 publications were retrieved. For a clustering of findings we

employed methods of deductive qualitative content analysis [eg. 87], based on both heuristic frameworks [cf. 88, 89] and inductive stages of qualitative content analysis. According to [85], three ways of citizen participation in urban planning can be distinguished (cf. Tab. 2). When it comes to *informing* the public, visualization techniques such as augmented reality (AR) offer a variety of innovative solutions to effectively support informational purposes, including mobile devices to display planning in-situ [90, 91]. That approach can easily be gamified, e.g. by implementing tasks and high-scores. In terms of *consulting* the public in matters of urban planning, formats focus on citizens as local experts and strive to collect neighbourhood knowledge by using mobile data collection tools [92] such as "Stereopublic" and "Widenoise" to capture noise levels and display them on a map [93] or to vote on urban planning ideas using high-score lists for raising user motivation [93]. Initiating an intense process of *collaboration* between the public and professionals is the intention of a gamified mobile app called "Community Circles". It rewards user interactions and contributions that refer to local urban planning issues with digital points [45]. Finally, the web-based online platform "Community PlanIt" is designed for assisting urban planning meetings, transforming an urban instance into a "mission" that contains game elements such as challenges, leader boards and in-game rewards. By completing those missions, the citizen contributes to the planning process, earning virtual coins which can be spent to support urban concepts that frame the topic [93]. What are implications for a platform design? First of all, mobile devices obviously lower barriers for participation and raise the chance for addressing a wider range of participants. Moreover, they allow displaying urban design proposals right at the spot, which may foster interest in public participation. Furthermore, gamification strategies show potential not only to arouse curiosity for participation formats but also to improve long-term user motivation to participate. Commenting and rating design proposals, sharing own ideas or playing goal-related project missions can be rewarded with points or badges, while formats of discovery motivate people to explore their district in order to find urban issues of public interest. At later stages, visualization techniques such as 3D environments and augmented reality sketches of future buildings show potential to make urban projects more exciting and tangible.

4.3. Communicating & decision making

One key challenge triggered by the application of digital co-design tools in urban planning is the overall decision making process. In the convergent ("rational") phases of a design project, responsible decisions must be made in order to select an appropriate solution from a multitude of alternatives created in earlier divergent ("creative") phases. Besides the information that is given at public events to citizens, online platforms provide a greater possibility to share and gather data belonging to a project. This includes proposals from the city, budget, time schedules, different media formats like photos, videos or 3d-models, comments, people involved, results of votings and/or rankings, and for example data collections through website analysing tools. But even technical data (e.g. legal framework, dimensions of constructions) should be available for the crowd [94]. The amount of data depends on the level of participation [95]. At a lower level the content comes from policy-makers, stakeholder or professionals (top-down). The more the citizens are allowed to participate, the more there will be a crowdsourcing process (bottom-up) [96]. Implications for a well done platform design are diverse and affect the information itself placed on the site as well as the way to communicate. The problem should be announced clearly with all necessary data that is available, with an interesting agenda, the goals that have to be reached and why the public is needed [97]. Only then the crowd will be activated and be creative to solve issues[98]. The design of the user interface has to be usable for all potential users and allow accessibility for all devices (e.g. smartphone, PC). Moreover, the information about a project has to be transparent, well understandable and unbiased to avoid framing effects [99]. It is very important that all users have a common understanding of the same subject and do not react in different ways. In the Boston Southwest Corridor project, Crewe [100] found out that "the more designers value the input of citizens, the more appropriate their designs will be for the users concerned". Furthermore, all involved persons (stakeholders, planners, designers, city authorities and the citizens) have to take part within the communication process because all of them have needs and interests. If all involved parties take part in the decision-making process, then you will show that you take the citizen seriously and to avoid the risk of resistance [101]. With the help of icons, pictures, labels and further descriptions, the different roles can be made visible for every end user. Corresponding to the profile, users have different rights, tasks and possibilities to affect the participation process. As described in paragraph 3.1 the participation process may consists of several rounds with different tasks and issues. For design purposes digital platforms have to com-

municate at least three topics: *"What to do?"* covers all tasks that may occur during a loop/round (e.g. inform, vote, comment, edit, share). *"Until when to do?"* means that the different stages for participation in urban planning are linked to individual time schedules until when a decision has to be made. *"How to do?"* describes the way a user has to interact within the platform to achieve a task. All tasks should be apparent without further explanations by using a variety of design and communication methods like alerts or hints on the project site or newsletter with a personal form of address. Any form of user action, regardless of the role, requires direct feedback to bridge the communication gap between direct and digital approaches. In Stuttgart at the Reallabor [58] citizens can easily get an impression of the look and feel by simulating a building within an existing environment in virtual reality. Augmented Reality is best used in-situ to make an expanded reality tangible through the use of geo- and mobile-sensing like for the project "Talking Places Kaiserslautern" [102, pp.40-42]. As Burby already mentioned, a proposal will be more accepted when involving people in the planning process and not just give them something to read about [103].

4.4. Sentiment analysis

To involve inhabitants in urban design planning a central aspect is to capture their concerns, agreement and ideas and to react appropriately. As it is the aim to allow all citizens to participate there will be a huge amount of feedback data which cannot be analyzed in a qualitative way. Furthermore, discussions about an urban planning project will not only taking place on the platform. Citizen feedback is also located on social media and newspaper sides. For that reason, there are two main challenges for feedback processing. The first consists of analyzing and monitoring a huge amount of emotional feedback data based on different communication channels as source of information. The latter refers to a specific output format offering some useful knowledge how to improve or adjust the planning for architects and urban authorities. The automation of analyzing textual feedback data is done by a sentiment analysis which is often used synonymously with the term opinion mining. It can be defined as "[…] the computational study of people's opinions, attitudes and emotions toward an entity. The entity can represent individuals, events or topics." [104] The most intuitive way to detect emotions in texts is to look for "[…] fairly unambiguous affect words like happy, sad, afraid, and bored." [105] However, extensive wordlists are needed as those words are not present in every expression bearing an emotional meaning. In lexicon-based approaches certain sentiment scores are assigned to many different, more ambiguous words based on their use to express certain emotions. After harvesting those words the lexicon is used as data base for sentiment analysis. Another kind of sentiment analysis are those methods based on machine learning. Texts with information about each expressed sentiment which were produced by human annotators are needed for training. Different classifiers are then used for sentiment detection. For a more detailed introduction into lexicon-based and machine learning approaches of sentiment analysis, see [106] and [104]. In addition to the applications in research mentioned before, there are many business solutions for sentiment analysis, e.g. by IBM [107] or Repustate [108], as many companies are interested in evaluating their products or services in a quantitative way based on social media data. Moreover, there are some initial approaches of sentiment analysis in the field of urban planning and urban design. They are also subsumed under the terms social media or semantic analysis and will be presented in the following. As members of the Telltale and Urban Sensing project, Ciuccarelli et al. [109] introduce different tools and methods to use geo-located social media data, e.g. from Twitter or Foursquare, as a source of knowledge for urban planning and design. The sentiment analysis is part of a text-mining component and, therefore, combined with several natural language processing methods, e.g. topic classification, named entity recognition and keyword extraction. Several visualization methods, e.g. of georeferenced twitter data, are tested to provide some useful access to the results of the analysis. Another solution is provided by the SocialGlass project which was already tested successfully through the evaluation of three different city-scale events [110]. In that case, special attention was payed to sentiment analysis as part of a social media analysis sub-system. Finally, within the Urban Emotions project conducted by Resch et al. [111, 112] a semi-supervised learning algorithm is used to classify and detect several emotions based on Twitter data. Those crowdsourced results are then combined with objective measurements based on wearable sensors together with subjective observations which were collected via App-based surveys. Thus, a few useful applications for sentiment analysis in urban planning are already developed.

Sentiments are detected as numeric scores on a certain scale or graph-based labels which lead to certain visualization formats. However, one shortcoming of those measures is that they provide no further insight into the aspects

which caused the sentiments. That knowledge can be very helpful for urban planners and authorities to adjust their planning according to those reasons which lead into a certain sentiment. Therefore, a combined approach of text and sentiment analysis for target-based opinion retrieval will be developed in our project. In the following, some initial results based on a prototype tool will be presented focusing especially on the text analysis as pre-processing step. The following results are based on a collection of articles about urban planning from The Huffington Post (http://www.huffingtonpost.com/news/urban-planning/) as text corpus for testing.
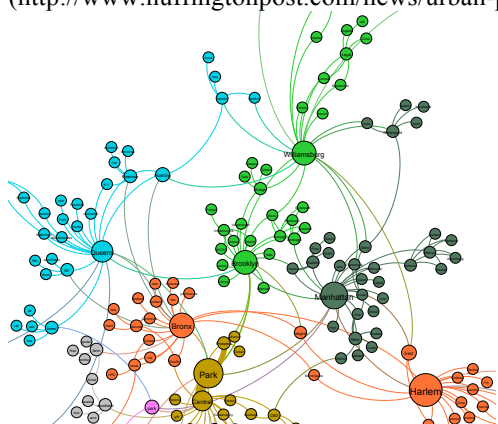

Figure 4. Visualization of parts of the city New York as target words together with their collocations in a Rhizome

<u>49</u> York City real estate market , it appears that East <u>Williamsburg</u> is no longer the city 's newest " neighborhood .

<u>317</u> Counsel of Brooklyn Legal Services , Marty Needelman advocates for <u>Williamsburg</u> 's most vulnerable residents .

<u>317</u> As little as 20 years ago , <u>Williamsburg</u> was among the poorest and most densely populated neighborhood in

<u>317</u> Now , <u>Williamsburg</u> hosts film shoots , art festivals , and vibrant entrepreneurship

<u>317</u> resources to the area , but the rent-regulated homes of <u>Williamsburg</u> are being systematically and violently dismantled by crooked landlords .

<u>317</u> As I was walking around <u>Williamsburg</u> with Marty , I figured out pretty quickly that he

<u>51</u> year (2008) and the bike traffic on the <u>Williamsburg</u> Bridge tripled .

<u>220</u> it 's not likely the current hipster nation known as <u>Williamsburg</u> would be as ' hip ' as it is now

Figure 5. Key words in context of the target word "Williamsburg" with the corresponding article id

In preparation for analysis, different target words, condensing key ideas, design proposals, parts of the city etc. as issues of an urban planning project are defined. Based on the target words and social media data (or newspaper articles, as in this case) a text analysis is performed by calculating collocations, i.e. "[…] a combination of two words that exhibit a tendency to occur near each other in natural language, i.e. to cooccur […]"[113]. For every target word a list of statistically significant collocations, i.e. words which are often named together with that target word, is assembled. Furthermore, a list of key words in context, i.e. a snippet of x words preceding a target word and y words following that word, is stored. The snippets are parts of different sentences in the corresponding newspaper articles. For each snippet, the unique article id is assigned. The main idea of the prototype tool is to visualize the target words together with their collocations as nodes in a network graph, called "Rhizome". Based on this text analysis and visualization format, we aim to detect concerns, agreement and ideas emerging in different social media channels as collocations of those predefined target words. Moreover, we offer a guided access to the sources of analysis. By selecting a node within the Rhizome, a list of key words in context is shown. Access to the several corresponding articles is further offered by clicking on the article id. Fig. 3 provides an example of the described approach. Single parts of the city New York are visualized as target words together with significant collocations within a Rhizome. The corresponding list of key words in context of the node labeled "Williamsburg" is presented in Fig. 4. The key words in context, respectively, are preceded by the corresponding article id. The sentiment analysis is going to be applied to the key words in context and article level. We will further include the results of the sentiment analysis in the visualization. Furthermore, it is important to mention that, for transparency reasons, insights into the results of the sentiment analysis are not only given to the planning authority but also to the citizens.

5. Conclusion and next steps

A current state of research on public participation in urban planning by digital means covers many facets. While the original concepts of public participation were primarily motivated by environmental and societal challenges as well as public participation in governance, topics of urban planning gained increasing importance especially during the last two decades. Against that background much research was done on phenomena such as participant selection, communication channels and methods. While most of the approaches of public participation in the pre-digital era dealt with small groups of participants and face-to-face workshops, the use of digital tools adds opportunities to easily involve large numbers of participants as well as to overcome restrictions of joining the same locality. Furthermore, several challenges arose, as for instance to extract information of relevance or to deal with heterogeneous technical prerequisites and communicational strategies. Against that background this article determines a state of the art on public participation in urban design planning by using digital tools. Due to the vast amount of research on public participation as well as the plurality of approaches and disciplinary domains involved, this article may strive for providing an overview on that topic and related aspects but will be limited in providing a comprehensive and complete view on a state of the art. Moreover, many topics of relevance could be dealt with only briefly and are discussed in more detail in further publications [10, 86]. A next step will be to further conceptualize a participative platform design taking the derived best practice and implications into concern. Since weaknesses of many previous research projects on digital tools for public participation are their poor involvement and testing in practical scenarios as well as often insufficient assessment and validation, our special regards are on intensive user testing and evaluation in real-life planning projects.

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