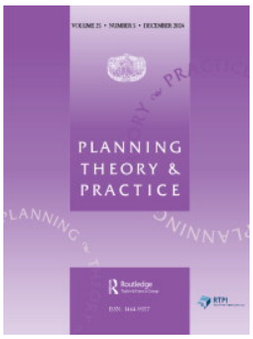

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3D Geovisualizations and Participatory Land-Use Planning – Planners' Perspectives from Finland

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ABSTRACT

Our article discusses the use of 3D geovisualizations in participatory planning in Finnish municipalities. The data from a survey and interviews among the municipality-level planners is analyzed from the perspectives of three discursive spaces: representational, experiential, and institutional. Our study shows that 3D geovisualizations are regarded as attractive tools, but their usage is sporadic, and the benefits are mostly evaluated on the basis of technical and representational qualities. Rather than increasing the role of citizens in planning, the new technologies partially reinforce the role of planners, albeit entailing the potential to support interaction with citizens.

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3D model; 3D visualization; collaborative planning; participatory process; discursive space

Introduction

New arenas and technologies for public participation in land-use planning have emerged in recent decades following a demand for reciprocity in public engagement (Sager, 2018). This development combines several ideological trends of reconfiguring the relationships between decision-makers and stakeholders (Cornwall, 2004), such as the increased demand for social inclusion (Healey, 1997, 1999) and the growing importance of the local scale as a counterweight to centralized regulatory governance (Gunder et al., 2018; Herbert & Chen, 2015; Purcell, 2006). These perspectives are interconnected with the digitalization of societies, and provide innovations for collecting and storing data (Anttiroiko, 2021; Gordon et al., 2011; Potts, 2020).

Planning institutions need to "recognize and negotiate among pluralistic conceptions of the good" and adjudicate among competing representations of place (Williams, 2014, p. 81). This has resulted in increased use of new digital technologies that aim to provide a shared language for parties in land-use planning, disentangling top-down mechanisms and stimulating new kinds of responses (Lovett et al., 2015; Staffans et al., 2020; Tobias et al., 2016). One of these technologies is 3D geovisualization, which was originally used by planners to design and evaluate plans but has recently become an attractive tool for public participation.

This development has raised scholarly interest in the usability of 3D geovisualizations in participatory and collaborative planning processes. The focus has been on technical solutions and user experiences (Julin et al., 2018; Onyimbi et al., 2018), the relationships between 3D environments and sense of place (Jaalama et al., 2021; Newell & Canessa, 2018), and the

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abilities of geovisualizations to produce relevant data (Herbert & Chen, 2015; Wissen Hayek, 2011). By contrast, the technologies have seldom been studied in relation to the power structures and legislative preconditions of planning (cf. Bouzguenda et al., 2022). Eilola et al. (2023) noticed that most usability studies concentrate on experimental settings instead of real planning processes, and conflicting planning cases are rarely evaluated.

In many countries, planning is increasingly digitalized through the development of geospatial data, artificial intelligence, and policies that promote digitalization. Nevertheless, Geertman and Stillwell's (2009) concern about the inadequate implementation of new technologies still seems relevant today. We might, therefore, ask what 3D geovisualizations offer participatory planning across scales: how they can help to utilize multisensory and experience-based information on places (Grêt Regamey & Fagerholm, 2024). Deeper understanding of possible structural impacts is also needed. Since new technologies entail the potential to affect the planning institutions and procedures (Potts, 2020), we need to ask whether the technological developments and growing interest in digitalization support communicative planning instead of re-establishing the rational, expert-, or technology-led planning paradigm (e.g., Bäcklund & Mäntysalo, 2010).

This article investigates the use of and discourses related to 3D geovisualization in Finnish municipalities. The ongoing reform of the Land Use and Building Act of Finland promotes digitalization in planning, which benchmarks Finland as an internationally interesting example of the use of new technologies in planning and participative processes. Our work is based on a survey sent to all Finnish municipalities, and follow-up interviews with 12 local planners. We address the following research questions to illuminate the interconnectedness of planning cultures, institutional frames, and the perspectives of planners as the end users and intermediators of the new technologies: Which interests and preconditions affect the use of 3D geovisualizations in participatory planning in Finland? Which kinds of municipalities are using 3D geovisualizations? What kinds of knowledge do the municipalities wish to gain by using geovisualizations? The concept of 3D geovisualization in this study refers to all georeferenced digital 3D-based representations of the physical environment (see Eilola et al., 2023; Jaalama et al., 2021).

We discuss our results hermeneutically from the perspectives of three discursive spaces – *representational*, *experiential*, and *institutional* – that bring together distinctive perspectives on the relationships between planning institutions, stakeholders, the material and experienced world, and 3D geovisualizations. We have derived these categories from the scholarly literature on geovisualizations, representations, and planning, and understand them as compositions of expectations, narratives, and perspectives that form multidimensional and spatial relationships between the technologies, practices, people, and planned environments (e.g., Maciag, 2018, 2022). We summarize with conclusions on the ways in which the roles and contents of 3D geovisualizations are affected by planners' expectations and by use in participatory and collaborative planning.

Discursive Spaces on the Use of 3D Geovisualizations for Participatory and Collaborative Land-Use Planning

Changes in interrelations between the institutions of power, society, and the environment are interwoven in planning cultures and practices (Gunder et al., 2018, p. 2). Consequently, the relations between planning institutions and citizens take new forms as new planning theories prevail in changing societal conditions (Bäcklund & Mäntysalo, 2010; Healey, 1997). These shifts

partly reflect the development of information and communication technologies (Anttiroiko, 2021; Potts, 2020; Staffans et al., 2020), but established policies may also fail to follow the theoretical or technological development and decelerate the implementation of new tools and methodologies (Bäcklund & Mäntysalo, 2010).

The recent collaborative approaches may support inclusiveness in planning (Gordon et al., 2011; Koontz, 2005; Sager, 2018), but Kahila-Tani et al. (2019, p. 45) identified three phenomena that hinder the execution of influential, large-scale public participation: planners may lack sufficient skills, broad audiences are hard to reach, and participatory data are seldom systematically analyzed or utilized. 3D geovisualizations have been welcomed as a partial answer due to their potential "(1) to support individual information processing […], (2) to stimulate participant discussions, and (3) to achieve the objectives of information transfer and planning tasks in different phases of the planning process" (Jaalama et al., 2021, p. 2; e.g., Onyimbi et al., 2018).

However, the implementation of 3D geovisualizations in communicative planning faces challenges. The 3D geovisualizations are goal-driven simplifications of material spaces, and their message depends on what is included or excluded (Potts, 2020; Voinov et al., 2018). They tend to emphasize vision over other senses and impact how the plans are received and discussed by stakeholders. Moreover, issues with usability and compatibility have prevented 3D geovisualizations from reaching their potential in participatory planning (Julin et al., 2018). The contexts of using geovisualizations also vary. As Herbert and Chen (2015, pp. 23–24) point out, "it is not fully known in what situations a 3D visualization may help users to understand the environment better," and "clear guidelines as to when, or for what planning tasks, a 3D visualization might be best utilized" are lacking.

These challenges intertwine with broader contexts of participatory practices, which Chouinard and Milley (2016) have analyzed using spatial metaphors. Following their perspective, and drawing on Maciag's (2018, 2022) conceptions, we have identified three discursive spaces that reflect the contexts of the utilization of 3D geovisualizations in participatory and collaborative planning. By *representational space*, we refer to conceptions that emphasize the representational relationship between 3D geovisualizations and material environments and, in a broader perspective, the desire to plan for governing physical space. Geovisualizations are easily framed through their abilities to help planners to perform visibility and coverage analyses and test the functionality of planning options among wider audiences. Moreover, 3D geovisualizations are often used to communicate static goals instead of to support an adaptive process between people's perspectives and planning proposals (Grêt Regamey & Fagerholm, 2024). Hence, questions of resemblance, detailedness, and usability are considered important.

The interaction between 3D geovisualizations and stakeholders has the potential to exceed the questions of visual correspondence despite the common emphasis of representational aspects over the multisensory and affective interconnectedness between people, communities, and places (e.g., Ingold, 2000; Waterton, 2013). Thus, we pay attention to *experiential space*: the understanding of 3D geovisualizations as technologies that capture and stimulate people's experiences, or their sense of place (Stedman, 2003; Williams, 2014). The role of geovisualization in participatory planning is evaluated, from this perspective, through the ability to trigger reactions that evoke participants' place-based emotions, attitudes, and general knowledge of places (Jaalama et al., 2021; Newell & Canessa, 2018), thus paving the way to incorporate affects and conceptions into the planning knowledge base.

Bäcklund and Mäntysalo (2010, p. 335) claimed that "any practice, reflected upon or not, is pregnant with planning and democratic ideals, with corresponding potential consequences"

(see also Healey, 1999; Pierre, 1999). Hence, we pay attention to the *institutional space*: the relationships between 3D geovisualizations and the soci(et)al contexts in which they are used. Our approach stems from the ideas of land-use planning as a policy assemblage that comprises relational and interdependent connections between theories, technologies, actors, and norms (Müller, 2015; Savage, 2020). Institutional contexts and interests define the potential and roles of 3D geovisualizations, affecting both the uses of technologies and actor positions in the use of technologies. At the same time, the technologies entail the possibility of affecting these frames.

The Study

Case Finland

Municipalities in Finland execute and oversee local land-use planning, but stakeholder engagement is required according to The Land Use and Building Act (132/1999; Ministry of the Environment, n.d.). Officials prepare and propose general plans and detailed plans, and elected local councils accept them. Such an arrangement gives the municipalities remarkable power concerning land use, while planners have a significant role in designing the actual plans and the planning processes.

The current Land Use and Building Act originated in 1999 and is being reformed. Reformation was preceded by evaluations, carried out by the Ministry of the Environment in 2012–2014, that noted that land-use planning should be based on all-encompassing, standardized models instead of myriad overlapping databases (Ministry of the Environment, 2014). The participatory processes were evaluated as ineffective, and their impact was seen as scarce due to planning cultures and practices.

Attempts are now being made to give the stakeholders better opportunities to participate during the preparation phase in planning (Ministry of the Environment, n.d.). In addition, the development of digital technologies has been recognized, noting that methods for analyzing participatory data have not developed alongside them. Consequently, as four new acts are set to replace the current one, starting with the new Building Act in 2025, all plans should be made in a nationally commensurate data model format that promotes the digitalization of land-use planning. This makes the development of 3D geovisualizations a topical issue in Finland, which already ranks first among the EU Member States in the Digital Economy and Society Index (European Commission, 2023).

Data and Methods

We contacted all Finnish municipalities (N = 309 [of which 59 are urban, 62 semi-urban, and 187 rural, following the Statistics Finland (n.d.) grouping of municipalities "by the proportion of the population living in urban settlements and by the population of the largest urban settlement"]) in April 2022 by sending a link to a Webropol survey that addressed the general use of 3D geovisualizations and the use of 3D geovisualizations in participatory processes. The questions about general use touched upon such topics as why and on what scales 3D geovisualizations are being used, which elements they contain, and how the municipalities acquire them. Regarding the latter, we asked with which stakeholder groups the 3D geovisualizations have been used, on which scales and phases of participatory practices they have been used,

and what kind of knowledge has been or is envisioned to be collected using them. The body of questions varied depending on whether the municipalities had or had not used 3D geovisualizations in participatory processes. The survey was available in both official languages: Finnish and Swedish.

We sent the survey link to the officials in charge of land use and planning, and later to the registry offices to be forwarded. The link was open for two months, during which we received responses from 110 municipalities. Respondents identified as their work assignments land use planning (74), administration (21), or technical service (14). We classified the survey data into three groups by the statistical grouping of municipalities (urban [N = 31/28.2%], semi-urban [N = 30/27.3%] and rural [N = 49/44.5%]). The response rate per municipality group was 52.4% for urban, 48.4% for semi-urban, and 26.2% for rural. The statistical significance of the survey responses and the differences across municipality groups were tested using the Kruskal-Wallis test when there were enough observations for statistical testing (i.e., a group with a sample size of 5 or more; University of Virginia Library, n.d.). Only statistically significant differences are reported.

We handpicked representatives of ten municipalities for interviews after analyzing the survey data. One interviewee represented two rural municipalities, but we treated them as one because their answers were valid for both municipalities. Two municipalities were represented by two interviewees. We focused on municipalities that had used 3D geovisualizations in participatory processes, but also interviewed representatives of three municipalities that were planning to use geovisualizations (Table 1). The semi-structured interviews, conducted in June and July 2022, were based on ten questions presented in random order and context-dependent formulation.

The questions reflected topics that covered all the discursive spaces, and we structured the responses in relation to our theoretical framework. In our analysis, we considered how the respondents' views either reinforced or challenged these spaces. We collated the responses with the research literature on which we had based our ideas of three discursive spaces. The analysis thus involved hermeneutic triangulation among the theoretical basis, the interview material, and our interpretations.

Table 1. Interviewees and their affiliations.

Interviewee	Title	Statistical grouping	Population*	3Ds used in participative planning**
1	Zoning head	Urban municipality	20,000–50,000	occasionally
2	City planning chief	Urban municipality	5,000–20,000	occasionally
3	Zoning architect	Urban municipality	Over 100,000	actively
4	Regional architect	Rural municipality	Under 5,000	no
5a	Zoning planner	Urban municipality	20,000–50,000	no
5b	Zoning architect	Urban municipality	20,000–50,000	no
6a	Team manager	Urban municipality	Over 100,000	actively
6b	Architect	Urban municipality	Over 100,000	actively
7	Zoning architect	Urban municipality	50,000–100,000	occasionally
8	Zoning head	Urban municipality	20,000–50,000	actively
9	Senior specialist	Urban municipality	Over 100,000	have piloted
10	City planning chief	Semi-urban municipality	5,000–20,000	no

*We use approximate values in order to secure anonymity.
**Among residents.

Results

Use of 3D Geovisualizations in Finnish Municipalities

Almost half (49.0%) of Finnish municipalities that responded to the survey (n = 110) use 3D geovisualizations in land-use planning. However, the rates vary statistically significantly based on the type of municipality, indicating that the use is mostly an urban phenomenon (applied by 90.3% of urban, 50.0% of semi-urban, 22.4% of rural municipalities, $H(2, n = 110) = 34.69$, $p = 0.001$). The use of 3D geovisualizations is still occasional in most municipalities (63.0%, n = 54) (Figure 1a).

Planners commonly considered 3D geovisualizations to mostly benefit detailed planning (88.9%, n = 54), whereas only a quarter of municipalities had used them in general planning (Figure 1b). However, usage outside the official processes in other types of planning projects was prominent. Respondents clearly emphasized the drafting phase in planning (Figure 1c). Urban municipalities used 3D geovisualizations in the ideation, starting, and implementation phases more often than did rural and semi-urban municipalities. Although these categories may have been understood somewhat differently, the deviation reveals that 3D geovisualizations are seldom used in the evaluation phase.

The 3D datasets are mostly for within-institution use only or partially open access. Only three urban municipalities and one semi-urban municipality allow full open access to their data. 3D geovisualizations were often purchased from consultants or other providers (73.5%, n = 53), but 64.3% of municipalities produced visualizations themselves. Municipalities most

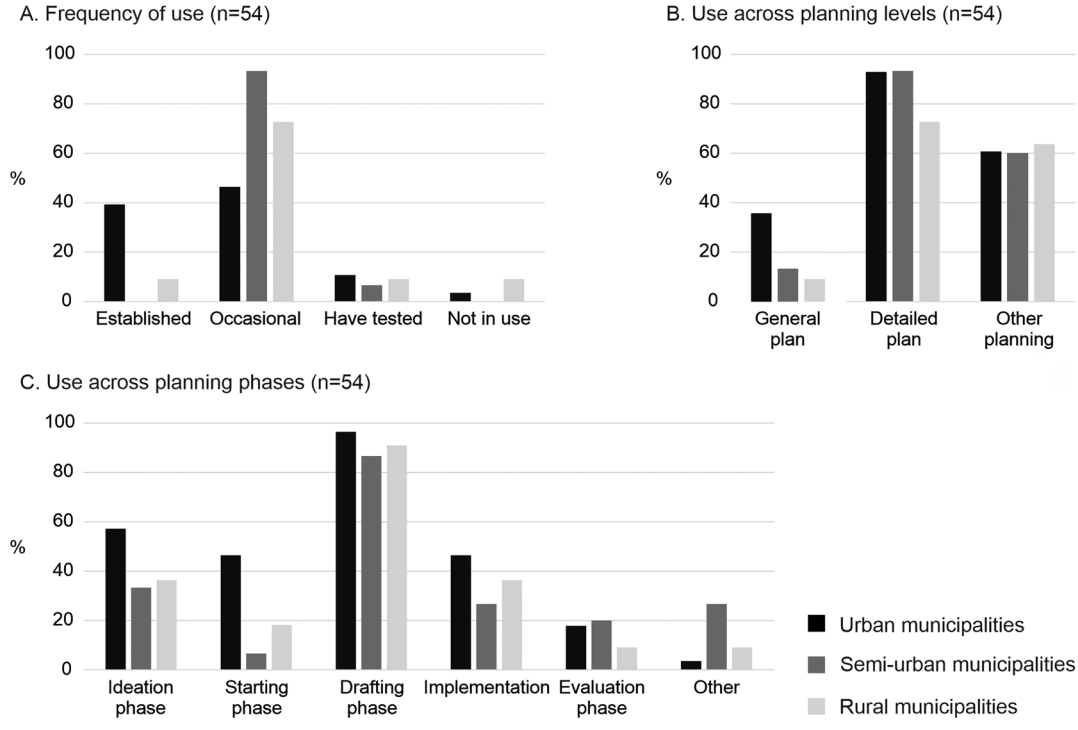

Figure 1. Use of 3D geovisualizations in land-use planning across Finnish municipalities.

often produced 3D geovisualizations at the wider city or municipality scale (66.7%, n = 54), followed by the scale of several city blocks (59.3%) and single block (51.9%).

Survey respondents reported that 3D geovisualizations are mostly used to represent the physical environment. All but one municipality had, in practice, represented buildings in their geovisualizations, and most of the models included roads, green areas, topography, and water elements. Statistical information (e.g., noise level, social data), by contrast, was modeled only in some cases, and functional elements, such as services, traffic flows, and air quality, in one municipality. The most common types of 3D geovisualizations used were illustrative images of buildings or mass modeling of broader areas, but the diversity of visualization types and means of use is remarkable.

Municipalities seldom used 3D geovisualizations to engage with citizens and other stakeholders. Of the urban municipalities, 16.5% had used 3D geovisualizations to receive information or comments from different groups, compared to significantly lower shares in semi-urban and rural municipalities (both groups 5.5%, $H(2, n = 109) = 20.59$, $p = 0.000$). The participants were mostly engaged in preparation phase (76.7%, n = 30) and official hearings (73.3%), but the 3D geovisualizations commonly featured in the starting phase of planning processes in urban municipalities (Figure 2a). Municipalities had applied 3D geovisualizations with local inhabitants (90.0%, n = 30), officials (70.0%), experts (50.0%), and interest groups (50.0%) (Figure 2b). Participation usually occurred in web-based applications (67.7%, n = 28) or workshops (42.9%)

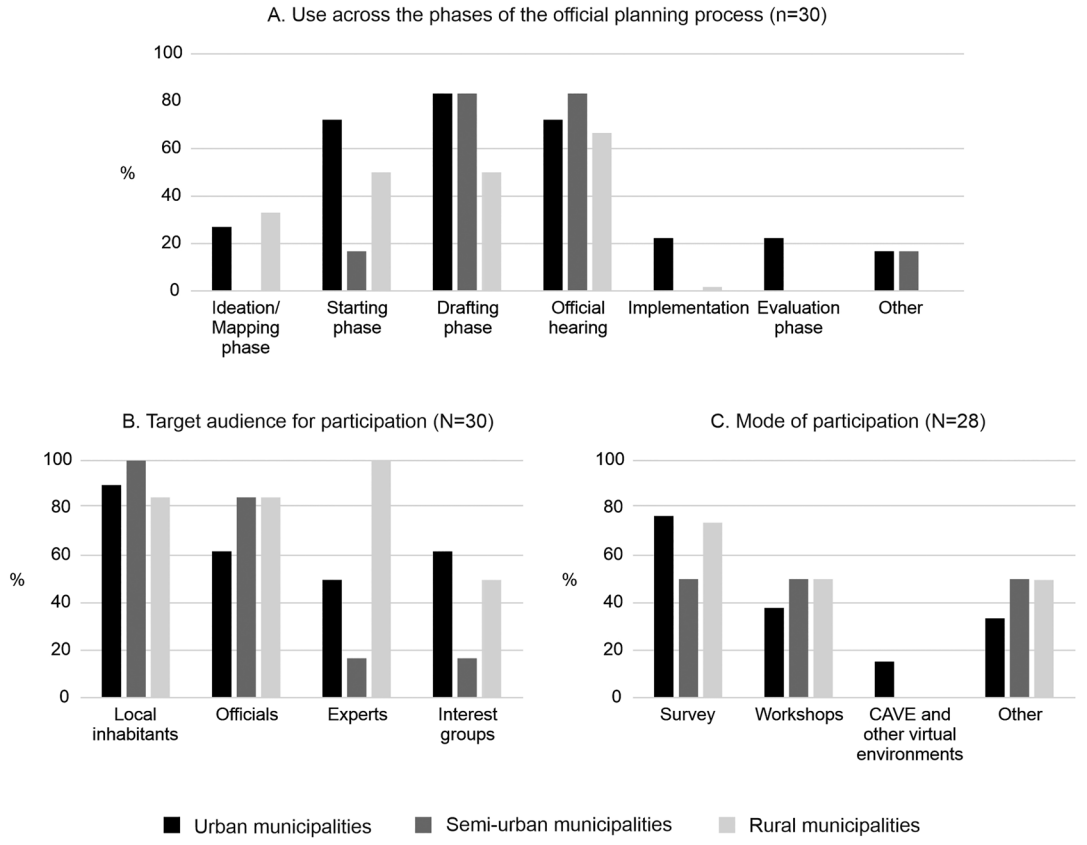

Figure 2. Use of 3D geovisualizations for participation in land-use planning.

(Figure 2c). Three urban municipalities utilized immersive virtual environments, such as CAVE (Cave Automatic Virtual Environment). Other modes of participation, mostly printed-out images from 3D models, had also been applied (39.3%).

The municipalities had primarily asked stakeholders about issues related to the location and appearance of buildings and about general opinions concerning the nearby surroundings and the plan itself. Urban municipalities sought also opinions about the qualities and characters of places and in gathering information about green areas. Issues such as locations and the supply of services or traffic were rarely discussed, and new ideas, background information, and evaluative or monitoring information were seldom collected through 3D geovisualizations.

Most survey respondents (93.3%, n = 30) considered the 3D geovisualizations useful in participatory processes, primarily for increasing the understandability of plans. The respondents claimed that 3D geovisualizations help the participants to share experiences (56.7%) and bring forth new perspectives (60.0%). A third of respondents mentioned the potential of geovisualizations in attracting new groups of stakeholders. However, only one respondent, representing a rural municipality, highlighted the possibility of allowing participants to modify the plans. The challenges mentioned were mostly related to technical usability (65.2%, n = 23), a low level of realism (30.1%), and challenges in attracting participants (30.1%). Other challenges included stakeholders commenting on irrelevant issues, data accessibility, and unbalanced representation of participants.

Most of the municipalities were quite satisfied with their participatory practices (rated 3 and 4 on a scale of 1–5), yet some wishes were expressed: 22.7% of the 110 municipalities wanted to develop their digital platforms, and 11.8% wanted to raise general interest in planning and improve the representativeness of the planning material. 3D geovisualizations provided one solution to the municipalities' desires to receive knowledge of participants' wishes and needs (26.3%), place-based information (24.5%), and general perspectives and feedback on plans (20.0%). However, 3D geovisualizations entailed some challenges, too. Those mentioned most often were lack of expertise among planners (71.4%, n = 54) and the high price (32.1%) or low availability of sufficient data (14.3%). In all, 14.3% of planners surveyed indicated that the information received through 3D geovisualizations does not support local planning processes.

Planners' Perspectives on 3D Geovisualizations

The survey results were deepened in ten semi-structured interviews with the municipalities' representatives. Seven of these municipalities had used 3D geovisualizations in participatory processes, and in the other three, the planners were familiar with and interested in using them. The interviewees had used or tested 3D geovisualizations in many forms, and proved quite receptive toward the visualizations, mostly due to the technology's effectiveness and attractiveness. Alongside usability, these attributes were considered most important regardless of the types of 3D geovisualizations. However, the interviewees mentioned several problems in deploying 3D geovisualizations, such as the lack of technological standards, challenges with usability, and mismatches between the demands of planning and technological development.

The most common types of 3D geovisualizations used among the interviewees were videos, 3D models shown in workshops, and applications used in online surveys. Gamified geovisualizations were used in one municipality: their role remained experimental. In general, models were primarily used (or were expected to be used) to receive feedback about proposed plans,

to increase planners' understanding of the use of certain places, and to increase the interaction between planners and stakeholders.

The interviews suggest that 3D geovisualizations are mostly used on a case-by-case basis, predominantly among stakeholders in small projects doing detailed planning. However, their use in participatory processes was considered potentially valuable. Some interviewees saw geovisualizations as supplementary tools that potentially provoke unexpected viewpoints and educe the kind of information that maps cannot bring forth, but some noted that the feedback seldom opens totally new perspectives to the plans. Three interviewees stated that geovisualizations enabled fruitful viewpoints in the workshops, as stimulus material. In these cases, the benefits of geovisualizations partly depended on the ability of facilitators to document the discussions.

All the interviewees admitted that 3D geovisualizations require remarkable investments, which can be hard to justify given the public sector's challenging economic conditions. They claimed that many planners do not have the time to learn to use 3D geovisualizations or to follow the field's development. This is especially the case in smaller municipalities that, according to their representatives, lack both the personnel and complex planning projects for which a 3D-based participatory process would be necessary. As I7 stated:

> It is usually the case that all sorts of technical innovations emerge, but then the training remains too scarce, so that […] the threshold for putting the tool to use is too high. […] If we were able to […] or wanted to process them more, it would clearly require more, like, training, and changing the operating methods.

The interviewees discussed the life cycle of 3D geovisualizations. In many municipalities, geovisualizations have been project based, with their use ending alongside the projects. In addition, the know-how has in some cases been lost after personnel changes. To make the use more continuous, some interviewees speculated that 3D geovisualizations should be developed into larger data models that would combine digital feedback channels, data management systems, and real-time GIS to really benefit the planning phase. However, many municipalities currently struggle with bringing existing data and platforms together. Discontinuities are not only technical but may reflect statutory competitive tendering, which enables municipalities to commit to certain services for a limited time. Some interviewees were skeptical toward the rapid development of new technologies, stating that technologies should adapt to the needs of planning and not vice versa:

> I hope it doesn't start to steer the contents of planning. […] Yes, it is, like, it is rather an instrument… or it should be […]. Well, you can say that certainly, like, the […] the instrument, the tool, to some extent always steers the content. It can allow you more opportunities […]. (I2)

> It feels so easily that it's just going to go off, like "hey, you can do this too, so let's do it." […] And, like, perhaps it's not always asked what is the [benefit] of it… (I6b)

Most interviewees recognized that planning in Finland is taking remarkable steps toward model-based procedures following the reformation of the Land Use and Building Act. However, the representatives of less populated municipalities emphasized that in rural areas it is not meaningful to model the whole municipality in detail because a great proportion of the area is not within the scope of detailed planning. Even though 3D geovisualizations were seen as suitable on the scale of regional and zoning plans, and outside of the built-up areas (e.g., visibility analysis for wind power plants), they prove most useful in intensively built areas where

multivocal discussion is desired. A similar perspective was presented by the representative of a declining city (I7) where the need for new plans is minor:

> We do not have the pressure to build; that is, it does not come from a demand that we would have to produce something like 1,000 homes every year, for example. In such a situation, we would have a completely different organization and a completely different starting point for this […] Now it is like, there is not such a need…

Discussion: 3D Geovisualizations and Discursive Spaces

Representational Space

3D geovisualizations are "just" representations (Lovett et al., 2015) despite being immersive and close to people's ways of perceiving places (Onyimbi et al., 2018). They easily reinforce the idea of land-use planning as rational, expert-led management of the material world, instead of bringing forth the complex interconnectedness of different elements and actors (e.g., Grêt Regamey & Fagerholm, 2024; Potts, 2020). Our results indicate that the usefulness of 3D geovisualizations is mostly evaluated through their representational functions. Thus, geovisualizations are constituents of *representational space*, which emphasizes the abilities and technical readiness of visualizations to support a shared understanding of land-use plans.

Planning is mostly about managing material space, or governing social space through material elements, so it is fair to say that 3D geovisualizations reflect ways of planning to approach the environment through formability. Most interviewees concentrated on the abilities of geovisualizations to "realistically" replicate features that would be converted into abstract or symbolic forms in two-dimensional representations, such as maps. They believed that, due to these abilities, geovisualizations help participants to understand plans, talk about their concerns, and, as a result, contribute to the planning process, or at least learn to know the plans profoundly. This is captured by comments from I5b and I3, respectively:

> My own view is that a picture is worth a thousand words. And so, when you make, like, good images, people will understand much better what it's all about compared to if you had white boxes… […] A model like this is in a class of its own in communicating the idea to people.

> I feel that when […] people gather around the 3D, the discussion is fruitful. It gives more information to all parties and […] improves their understanding of what we are planning […].

The interviewees' positive attitudes toward 3D geovisualizations as communicative tools entailed a pragmatic aspect. The more realistic impression the stakeholders receive from the plan, the less surprised they are when it materializes. This, according to the interviewees, dispels some possible concerns and may support the approval of the plan. However, some interviewees stated that people may think they have been misled if the image transmitted by the geovisualization does not actualize like the depicted form. For example:

> There's a little bit of a fear […] that how we can market it in such a way that people don't think it's going to look exactly like this, a bit like we had with [one project site] where we introduced a conceptual image, and it looked completely different when it came into being… (I9)

The interviewees emphasized that, when discussing visual correspondence, the usefulness of different visualizing tools depends on the target and nature of the plan (e.g., Herbert & Chen, 2015). This is also true for the sufficient level of generalization of 3D geovisualizations

(e.g., Lovett et al., 2015, pp. 88–89; Wissen Hayek, 2011). Judging from the interviews, the detailedness of geovisualizations is a crucial issue that may affect the progress of the whole participatory process. The interviewees stressed the ability of geovisualizations to match the physical environment as precisely as possible (e.g., Wissen Hayek, 2011), while noting that it is necessary to generalize every model in a way that optimally conveys essential information to the stakeholders. Thus, attention must be paid equally to ways of representing the elements understandably and to understanding which elements are needed to provide useful information.

Experiential Space

Kahila-Tani et al. (2019, p. 47) argue that "participatory planning practices should apply the interpretative approach to […] planning where attention is simultaneously paid to the objective and physical matters of place and to the subjective and social concerns of place." The abilities of 3D geovisualizations to evoke these subjective concerns – people's sense of place (Jaalama et al., 2021; Newell & Canessa, 2018; Soini et al., 2012) – turn them into constituents of *experiential space*, which reflects the interests of planning institutions in exceeding the visuality and understanding the ways in which the planned environments are being perceived and lived in.

All the interviewees were, unsurprisingly, interested in the immersiveness of 3D geovisualizations. Some, for example, hoped that people would be able to orientate themselves in the visualizations as in physical space:

> [You get to] look around and see the real environment, so, like, indeed it gives you a completely different [experience] given that you're not there in the bird's eye view or higher up but you are set on the real ground surface, in a way, and get to wonder what everything looks like. (I9)

This, for its part, was believed to bring forth valuable perspectives on the planned environments: something that planners cannot ask directly but that the geovisualizations educe to enable planners to approach stakeholders as the experts by means of experience of the planned environments. This idea was summarized by I6b:

> So that when you're there in the model that simulates the real world, […] it comes more easily to mind that "oh yes, this is where I'm always bothered by this and this."

Jaalama et al. (2021) observed that people's background information and opinions about places affect the ways in which virtual spaces are understood, regardless of the accuracy or realism of geovisualizations. It is, thus, noteworthy to consider whose experiences the geovisualizations represent or reflect: do they emphasize the perspectives of adults or healthy people, or do they allow marginalized groups to recognize their lived environments and ways of consuming public spaces? This was only vaguely touched upon among the interviewees, who easily took the experientiality of 3D geovisualizations as a generalizable feature that can be accessed by anyone if the technical implementation is favorable.

The interviewees nevertheless claimed that the sense of place provoked by 3D geovisualizations tend to depend on people's abilities to move in the geovisualizations and find familiar viewpoints. This often paralleled the accuracy of geovisualizations, contributing to Wissen Hayek (2011, p. 928) claim that realistic visualizations support identification by triggering a sense of familiarity and even commitment to the landscapes. However, "a geometrically realistic impression of a scene may not necessarily generate the same perceptual reaction as the real landscape" (Lovett et al., 2015, p. 88; see also Jaalama et al., 2021; Newell & Canessa, 2018). Hence, many

interviewees were interested in incorporating multisensory elements in 3D geovisualizations to increase the affectivity of the models, recently highlighted as a key factor to enhance the efficacy of 3D geovisualizations (Grêt Regamey & Fagerholm, 2024). This became apparent by the comment of I8, for example:

> [The virtual model was] quite experiential for me too […] like, it was mid-winter when we looked at those summer beaches and the birds were singing, it was just as if you had been abroad for a while. […] I think [a person] made it so that he went around recording the sounds on the spot, so that for the local people it makes it, like, easier to locate themselves […]. And then, of course, when it is programmed to the right latitude and time of day, the light […] really comes from the right angle; it is a very […] realistic experience.

The affectivity of the 3D experience was also pondered in relation to the interaction between the planners and stakeholders. For example, many interviewees noted that there may be discontinuities between the virtual environment and the environment of interaction, and that the experiences may be hard to verbalize regardless of the quality and immersiveness of the geovisualizations. One interviewee explicitly pointed out that requests to discuss the plans intrude into personal space and turn it into a shared space where conditions are subordinate to the planning process. Similar concerns were addressed about the role of the assignment, which may affect the ways in which the represented environments are experienced and, thereby, what kind of information is received (e.g., Jaalama et al., 2021). I1, for example, pointed out that:

> Well, of course, you have to be precise; questions are always used to guide answers and so on […]. But we must strive to ensure that we do not try to feed something like a ready-made solution…

Institutional Space

Planning is a policy assemblage that is constructed and conducted through strategic relations to political imaginations, rationalities, technologies, infrastructures, agents, and desired impacts (Savage, 2020). The diversity of actors' roles as producers and managers of valid information affects the methods and technologies of planning (Bäcklund & Mäntysalo, 2010, p. 348), that is, the *institutional space* within which 3D geovisualizations are utilized. As a result, the means of using geovisualizations depend on the ideologies, cultures, goals, arrangements, and political preconditions of planning institutions. However, the impact is twofold. 3D geovisualizations allow planning institutions to adopt new forms and contents of interaction, paving the way for possible new perspectives to encounter with stakeholders in participatory planning processes.

This became apparent when we asked the interviewees to reflect upon the impact of legislative preconditions on the use of 3D geovisualizations. The legislation in Finland does not directly specify how participatory processes should be executed, but certain preconditions exist related to arranging official hearings and documenting feedback. Indeed, even though most of the interviewees claimed that the legislation does not limit the use of geovisualizations *per se*, many municipalities have chosen to use the technologies outside official public hearings, to produce additional information for the planning process, as a quote from I8 illustrates: "And the way [the information collected through the use of 3D geovisualizations] is connected to our official process, is that it is a kind of report." Such additionality has resulted in case-specific usage that may hinder the potential of the geovisualizations to contest the prevailing regimes and bring forth new kinds of knowledge (Anttiroiko, 2021, p. 44).

From the procedural perspective, the use of 3D geovisualizations in participatory processes proved to entail a paradox that two interviewees formulated in almost identical ways: stakeholder input is most important in the preliminary or early phases of planning projects (see also Kahila-Tani et al., 2019, p. 48), but it is usually not requested until the plan is about to be approved. Consequently, it remains unclear how the use of 3D geovisualizations exactly affect the plans' contents. Two interviewees explicitly emphasized that it is hard to verify the impact, and one stated that the impact depends on the planner. The dilemma was summarized by I1, who claimed that:

> There is the contradiction […] that in the brainstorming phase it should be… so it's like the most important phase to ask for […] feedback. So, when we […] have, like, almost ready-thought structure images of buildings, then at that stage requesting feedback is a little more, like, kind of cosmetic.

The procedural preconditions affect not just the use and role of geovisualizations. Grêt Regamey and Fagerholm (2024; see also Anttiroiko, 2021, p. 44) point out that the efficacy of 3D digital environments depends strongly on "who has power when decisions are made." Indeed, 3D geovisualizations are not immune to the impact of arrangements and power relations of planning. The interviewees confessed that the planning sphere is at least partially remote and strange to participants, and that planners inevitably approach the goals and processes of planning from different perspectives than stakeholders, sometimes narrowing the potential of new technologies to bring forth unexpected information. I10 pointed out that the participants regard the materials produced by officials as final outcomes rather than as invitations to discuss the plans:

> [W]ell, at least here in rural areas, [the stakeholders] indeed feel that [the plans] are, like, more distant. [O]f course they assume that the plans are ready made, and they do not dare to change them. […] In a way, that's because when these plans and others are made on these computers, they look ready.

To lower the thresholds of participation, many interviewees expressed subtle interest in gamified methods that enable participants to create their own plans or take part in constructing the visualizations (e.g., Nettley et al., 2014; Tobias et al., 2016). Such methods were seen as increasing participants' understanding of planning processes, which in turn would result in higher levels of reciprocity. However, many interviewees emphasized the risks that mixed roles may entail, given the unevenly distributed liability within the planning processes. Even though spaces for experts and the public "are not necessarily opposite ends of a spectrum" (Gordon et al., 2011, p. 506), planners have a clear idea of their role and responsibilities as handlers of the data and as managers of the process (Davoudi, 2018, p. 19; Sager, 2018). For example, I3 claimed that if participants are invited to propose their own ideas, they should be reminded of the roles and areas of responsibilities:

> It's probably just about how to inform the citizens. Like that you are not allowed to turn now into planners, but if you are interested, you can make a preliminary suggestion and we can then give some feedback, for example, on whether this can be considered or not.

Different contexts of governance create different modes of civic participation through which people construct their social identities (Healey, 1999). Thus, Bouzguenda et al. (2022, p. 27) claim that the biggest advantage of 3D-based participatory planning is the possibility to engage often-silent voices. This potential was recognized by all interviewees, who wished for multivocal planning and emphasized inclusiveness and the ability to engage people as vital qualities of

participatory processes. However, when asked which groups could be reached more easily with 3D geovisualizations, interviewees mentioned only young people, who are believed to orientate themselves effortlessly in digital environments.

This notion is not without problems. First, since 3D geovisualizations are engineered to produce knowledge based on the settings of questions of planning, they may exclude young people's informal uses of space (e.g., Kallio et al., 2015; Pyyry, 2016). Second, no interviewee mentioned other "silent" groups. This result is in line with the findings of Eilola et al. (2023), according to which the case studies of 3D visualizations rarely engage diverse citizenry and marginalized people. Indeed, despite the possibilities of 3D geovisualizations supporting inclusion and socially sustainable planning, the increased use of digital platforms may reinforce certain social hegemonies by emphasizing digital skills and possibilities of accessing digital information (Leclercq & Rijshouwer, 2022). As the following quotes by I9 and I3 illustrate, participatory processes are, after all, mostly joined by people who understand the contents and contexts of planning regardless of which technologies are being used:

> [I]t doesn't help at all that the participation [occurs] in the 3D world in areas where participation is really weak anyway, like, where people don't participate because they're not interested or they don't have the tools […] Active residential areas are, like, they are always the same ones, and then there are the same people and groups of people who participate […].

> Maybe younger people may be more interested and adapt better to these new platforms, but, well, it is probably […] quite a small number of people who attend workshops of this kind […] But as I said, the amount of feedback received through 3D models directly in digital form has been disappointing; they remain a few or zero per project, depending on how difficult the platform is and how well we know how to tell about them that something like this is in use.

Conclusions

The example of Finland shows that planners see 3D geovisualizations as convenient tools for gathering and processing data. The technology's significance is defined by ways of bringing forth new information or enabling planners to share their vision. These technologies are also useful for provoking stakeholders' and planners' sense of place and to illustrate planning sites. In this sense, the geovisualizations live up to promises that they may help planning institutions to develop citizen participation in the context of representational and experiential spaces.

However, the role of 3D geovisualizations, regardless of their type, is limited by institutional frames, such as planning contents and cultures, that do not necessarily support the inclusivity of planning processes. Incorporating new technologies requires economic and human resources, rendering the use of geovisualizations most prominent in large cities with more resources. Although planners recognize these preconditions and are willing to ponder the potentials of geovisualizations both in single planning cases and at the system level, the knowledge gap identified by Çöltekin et al. (2016) remains: there is no established understanding regarding what kind of data should be shown in the 3D digital environment, what type of representation should be used, for what task types, and for whom. Furthermore, our study indicates that 3D geovisualizations form "invited spaces," that is, institution-driven templates that maintain or even re-establish existing hierarchies, albeit allowing more nuanced discussions (e.g., Cornwall, 2004). In other words, 3D geovisualizations help people express and articulate their opinions concerning different places, and in optimal cases even deepen their knowledge, but

geovisualizations are also highly technological tools that run the risk of developing new forms of exclusive expertise around them. Consequently, it seems somewhat unrealistic that the application of 3D geovisualizations today would change planning culture. As one interviewee said, the technology itself would hardly lure people to participate if the topic or target of the planning project is not considered interesting.

To conclude, we recapitulate the most crucial findings on the roles and tasks of 3D geovisualizations within our analytical frame. From the perspective of *representational space*, the quality of geovisualizations is evaluated based on the visual correspondence. As a result, in many cases it is sufficient for geovisualizations to deliver plans illustratively; the planners communicate from their own perspective, and participants are expected to give feedback assisted by the representations. Consequently, there is little reciprocity and fluidity in communication. *Experiential space*, for its part, emphasizes the abilities of 3D geovisualizations to bring forth knowledge of participants' experiences and functioning in planned environments. Attention is paid to the ways in which geovisualizations equal peoples' experiences and enable participants to live up to their roles as experts on their local places, turning the stakeholders into active producers of knowledge. However, the discussion remains a collection of described experiences, and at least with the current resources, the knowledge remains somewhat formal. It should be integrated into planning processes more efficiently.

Finally, within the *institutional space*, the significance of 3D geovisualizations is judged by their ability to integrate participants into planning systems and to support profound dialogue among actors. This dialogue is, however, seldom equally inclusive or reciprocal, and geovisualizations may reinforce the existing power relations of planning. Many planners are willing to test new forms of data gathering, but they are aware of their professional roles and responsibilities. This awareness is related to the timelines of plans. Geovisualizations are often used at a stage when actual co-planning may no longer be fruitful: mixed roles would be most useful at an early stage of visioning, when there is rarely enough illustrative 3D data available.

Based on our results, we insist that the uses of 3D geovisualizations can be developed into more inclusive processes only when the complexity of the contexts in which they are being used is recognized methodologically and theoretically (e.g., Geertman & Stillwell, 2009). The potential and limitations of new technologies must be considered case-wise in the light of citizen accessibility, resources, desired information, spatial context, and scales of planning. Planners should also gain more knowledge of 3D geovisualizations through professional or on-the-job training and inform themselves of the tools available, as well as of what geovisualizations are particularly useful for and what not. If these conditions are being considered, it seems evident that alongside the gathering of diverse knowledge, 3D geovisualizations may enable and encourage planning institutions to critically reflect on their procedures and ways of communicating with stakeholders.

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