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Research Article

Digitalisation in everyday urban planning activities: Consequences for embodied practices, spatial knowledge, planning processes, and workplaces

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ABSTRACT

The article deals with the digitalisation of planning from a sociological perspective. The authors summarise results of their international empirical research in an analysis in which they place everyday digital planning practices at the centre of their considerations, where profound and intricate affects in planning occur at the level of embodied practices, spatial knowledge, planning processes, and workplaces. The authors examine the use of digital tools at different study sites and particularly discuss how the digitalisation of planners' actions through the use of Computer-Aided Design (CAD) programmes affects the way spaces are planned and how spatial knowledge is changing through the use of Geographic Information Systems (GIS). What is striking is that on the basis of digital practices, the relationships between planning actors are being refigured insofar as planning teams often work not only locally but at the same time globally networked and thus plan translocally. This refiguration through digitalisation (Knoblauch & Löw, 2020) in its social and spatial dimensions is also reflected in the design of workplaces (including the layouts of planning offices) as is shown in the article. Finally, it is outlined that risks and potentials for planning products are unfolding today through phenomena such as the digital datafication of spatial realities and translocal planning by the globally distributed members of planning teams.

1. Introduction

Historically, planning activities have always been associated with a pronounced use of media since the beginnings of urban planning. The first forms were city models or sketches, which have existed since the earliest history of urban planning. By means of media like these, urban development with its built, but also economic, ecological and social dimensions could be better analysed, planned and communicated to others. After analogue media had been part of the planning process for a long time, they have been gradually displaced since the 1990s and 2000s at the latest in the course of the digitisation processes taking hold worldwide, but have not disappeared completely. Since then, an increasing and comprehensive digitalisation of planning actions can be observed. It seems likely that digitalisation brings with it socio-spatial transformations for planning practices, for example that it changes the conditions and processes of planning and that it thus influences the way in which spaces are planned and thought about.

We refer here to the mediatisation thesis developed in communication studies (cf. Hepp, 2020; Krotz, 2007): This thesis is based on the observation that (ever) "new" media and, more recently, digital information and communication technologies in particular are

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increasingly used worldwide over time and tend to affect all areas of society. In this concept, digitalisation is seen as the most disruptive part of the history of mediatisation. In view of very extensive digitalisations, Andreas Hepp (2020) now even speaks of a "deep mediatisation", for which it is typical that all elements of our social world are closely connected to digital technologies and their underlying infrastructures. Even objects that are not traditionally considered digital media, such as a car, become media through their digital connectivity (cf. Hepp, 2020, p. 5). The central characteristic of digital media or technologies compared to analogue ones is that they are software-based and thus controlled by algorithms. Human actors who use digital tools can be affected by the specific properties and logic of individual digital technologies. It is thus assumed that human action changes in the course of increasing digitalisation processes and that the changed modes of action in turn bring about changes in the organisation of social worlds – for example, in everyday life or at work, as in the way we experience and shape the world.

Against this background and in view of comprehensive globalisation processes, Knoblauch and Löw (2020, p. 282) assume that a process of major refiguration of spaces has taken place. The fact that social actors can be (virtually) present in several places simultaneously and act in different forms of translocality depending on the (digital) media technologies they use illustrates this argument. Spatial constructs may thus be arranged in entirely new ways.

We transfer these assumptions and observations to the activities of planners and ask the following comprehensive research question: How does the digitalisation of planning transform everyday urban planning practices in typical planning offices and what are challenges of digital transformation for planning outcomes? This question has not yet been systematically investigated, as previous work on digital tools in urban planning has tended to focus pragmatically on optimisation possibilities for planning activities. The following article addresses this research gap by presenting results of a completed empirical research project that analysed digital planning based on selected cases in New York City (USA/North America), Frankfurt/Main and Berlin (Germany/Europe) and Lagos (Nigeria/Africa).

The article is structured as follows: Section 2 first outlines the state of the art and research in the field as well as the research gap. The methodological procedures in the research project, i.e. the case selection, the methods of data collection as well as those of data analysis, are described in Section 3. This is followed by the presentation of the key findings. We start with a look at the central digital planning tools that are at the forefront of the everyday planning practices in the empirical cases studied, what characterises them and how they changed previous planning practices (Section 4). More specifically, we will look at applications of Computer-Aided Design (Section 4.1) and the use of Geographic Information Systems (Section 4.2). Section 5 examines in depth the phenomena of digital data, datafication and the incorporation of algorithms as an essential basis for planning work. The finding that, in the course of the use of digital information and communication technologies, increasingly translocal planning of members in planning teams can be observed who work together spatially distributed, is examined in Section 6. In this context, we will also highlight – albeit only in passing – possible effects that this type of digital collaborative planning can have on planning products. This does not hide the fact that the work of planners is still done from planning offices, which, however, have also been re-arranged in spatial terms in the course of digitalisation, as we will show in Section 7. At the end, in Section 8, after a brief summary of the findings, the challenges of digital transformation, especially through datafication, the involvement of algorithms and the translocal action of planners, are discussed.

2. State of the art and research

Digital technologies have been part of urban planning for more than three decades. Only since the 2010s, however, has there been talk of a boom – due to ever better versions of planning software, for example for 2D and 3D simulations or even gaming.

In order to support work processes in urban structural planning, Planning Information Systems (PLIS) were developed in view of the increasing complexity of the data to be processed. These systems provide spatial data, maps and models in digital form. Information is prepared there in such a way that the estimation of future developments is facilitated and concrete planning needs for an area can be easily identified (Shen, 2012). Geographical Information Systems (GIS) are amongst the best-known systems. These enable planners to retrieve and link data on urban structural elements, social processes, environmental conditions or potential hazard situations in an area at the push of a button (Fang et al., 2014).

Digitalisation has also found its way into urban design. There, the focus is on digitally designing concrete built environments or spatial arrangements in cities. Analogue methods that once existed in urban planning were transferred to computer systems and have been further developed through applications such as Computer-Aided Design (CAD), which revolutionised urban design. However, typically, these applications not only offer design methods, but also methods of presentation. They allow the viewer to experience aesthetic qualities of architectural designs by 2D or 3D simulations (Al-Kodmany, 2002; Arisona et al., 2012; Christmann et al., 2020; Craig et al., 2001; Czerkauer-Yamu & Voigt, 2016; Lopes & Lindström, 2012; Lovett et al., 2015; Pinto et al., 2014; Ross, 2012; Silva, 2015; Yin & Shiode, 2014). With the help of Virtual City Models (VCM) 3D visualisations allow the viewer to virtually "fly" over the model and to view both complex topographic structures and architectural details from different perspectives (Al-Kodmany, 2002). VCM also makes it possible to merge virtual designs with the visualisation of real spatial structures and create augmented realities. Software programmes for the creation of – photorealistic – renderings of planned urban spaces should also be mentioned here, which have become widespread in recent years. They are used to achieve broad acceptance for certain plans as early as possible (Mélix & Christmann, 2022; Mélix & Singh, 2021; Schillaci et al., 2009; Stenslund & Bille, 2021).

Planning support science shows that changes in planning support systems, especially through the systematic introduction of new software and hardware tools, have an impact on planning processes (Brail, 2008; Geertman & Stillwell, 2020). The assemblage of different tools helps planners to better understand spatial phenomena, improve communication between stakeholders (Goodspeed & Hackel, 2017) and support decision-making processes (Assarkhaniki et al., 2021; Sabri et al., 2019). It became apparent that planning practices were significantly facilitated through the use of (digital) technologies. However, due to the increasing interdependencies between the supporting (digital) technologies and the planning practices, planning simultaneously became an ever more complex process based on the division of labour and organised in a translocal manner. We will explore this phenomenon in more detail in our paper on the basis of our empirical data.

In the meantime, digital presentation techniques and platforms on the internet have not only enabled new forms of communication with and participation of specific interest groups, but also of numerous citizens and a broader public. Smart city and e-governance tools are coming along, offering a variety of ways to inform and engage citizens (Bindu et al., 2019; Falco & Kleinhans, 2018; Hersperger et al., 2020, 2021, pp. 1–17; Rose & Willis, 2019). There are even gaming approaches through applications such as “Community PlanIt” or “Minecraft”, which invite not only young people to engage with urban design (Billger et al., 2016; Hudson-Smith & Shakeri, 2022).

It can be stated that ever new digital tools are constantly being developed and used (worldwide) to prepare and visualise planning for future urban spaces. And the Covid 19 pandemic may have even increased the use of these digital tools. When looking at the research literature on the subject, it is generally noticeable that it mainly discusses the advantages that digital tools can have in planning. It is hoped that they will lead to higher quality and higher transparency and at the same time to more efficiency as well as greater speed in planning. In particular, experiences with different digital visualisation tools for the representation of future urban spaces are described. In most cases, their potential for collaboration with stakeholders and citizen participation is discussed. The possibility of being able to visualise different planning variants at an early stage and to organise intensive communication with the stakeholders at an early point in time is seen as helpful in order to be able to weigh up decisions better and make them more quickly. The previous studies on these developments – mostly from planning sciences – are therefore rather pragmatic (see for example Shen, 2012; Pinto, 2014). As a rule, most contributions are concerned with reporting on experiences with specific digital tools, discussing technological and practical challenges, and pointing out optimisation possibilities. Often, the need to promote further standardisation of databases and software applications is discussed in order to be able to better exchange digital data as well as plans between different actors.

Only rarely do authors point out the characteristics and consequences of digital technologies for the everyday practices of the planners themselves and their work organisation, i.e. above all for embodied practices, knowledge production, planning processes, workplaces and office spaces in planning. Only Lange (2011, p. 404) points out in a marginal note that planning projects can increasingly be observed in which members of the planning team work on a project simultaneously from completely different places in the world with distributed work tasks and with the help of digital tools. However, it is significant that neither Lange in his article nor other contributions in the research literature treat this phenomenon more systematically and that no consequences for the planning of future urban spaces are reflected. We will take up these desiderata in our article.

3. Methodology

For the empirical investigation of our research question, “How does the digitalisation of planning transform everyday urban planning practices in typical planning offices and what are challenges of digital transformation for planning outcomes”, we selected three cases: New York City [USA/North America], Frankfurt am Main and Berlin [Germany/Europe], and Lagos [Nigeria/Africa]. These cases embody different stages of development of digital planning. Since the 1990s, the USA has been considered a global pioneer in digital planning, especially with New York City (Al-Kodmany, 2002). Frankfurt/Main and Berlin are seen as early adopters, well known in Germany due to urban planning authorities and offices that are willing to experiment with digital tools since the 2000s. Lagos is rather a late adopter. It was less advanced in the past, but has caught up significantly since the 2010s and has been described in the literature as a dynamically developing case in Africa (Adeoye, 2010). Through this broad distribution of local planning contexts, the use of digital tools was investigated under the most diverse conditions possible.

Between 2018 and 2020, we collected empirical data for several weeks at a time over a period of three years. The basis for our analyses is thus empirical research, in which over 50 planners and experts were interviewed, and two dozens of private planning offices and public planning authorities were visited. The selected institutions had many years of experience with digital tools. They have carried out numerous urban planning projects.

In terms of methodology, for the data collection we followed Knoblauch's (2000, 2005) focused ethnography approach, which typically combines participant observation, qualitative interviews and document gathering. In our study, we additionally took photographs of workplaces. Focused ethnography is characterised by short research visits in which we look at specific situations in a targeted way, instead of openly accompanying a group over a longer period of time as in “classic” ethnography. In the spirit of *workplace studies*, which is an important reference point for this approach, the modern workplace becomes the site of ethnographic research. Ethnographic methods offer ways to analyse the way planners plan, maintain relationships with colleagues and organise processes with the help of digital tools (cf. Eckhardt et al., 2020). Our research focuses on situated practices (Suchman, 1985) with situated knowledge (Haraway, 1988), in which people interact with machines and integrate them into their everyday work (cf. Goodwin & Goodwin, 1996; Knoblauch et al., 2021; Orr, 1996; Suchman, 1985).

For the analysis of the different data collected, we used the method of grounded theory analysis. The concept was developed by Glaser and Strauss (1967) and originally described how to develop a “subject-based” theory from empirical data. The procedure has since been elaborated into a very practical method for data analysis (Strauss, 1997). In our project, we used the grounded theory procedure in the latter sense – i.e. as an analysis method – in order to be able to break down our large data corpora analytically. The method is also well suited because it can be used to process different types of data (interview transcripts, field notes of observations as well as visual data). Typically, three coding methods are used successively in this procedure, with which the data can be gradually penetrated analytically: In open coding, certain phenomena in the data are first identified and named. In axial coding, the phenomena found are then systematically compared with their characteristics within and between the cases respectively. And in selective coding, recurring structural patterns are detected and abstracted from the concrete data.

4. Changing tools and tools of change in planning practices

A first finding of our research was that the use of – at least a core of – digital tools in planning was widespread and strikingly similar across the three study sites, despite the contexts being so different. It is particularly the use of Geographic Information Systems (GIS) and Computer-Aided Design (CAD) applications that proves to be a standard practice in the planning institutions studied.[1] Cutting-edge software tools for stakeholder and/or citizen involvement, on the other hand, were by far not used everywhere. Therefore, for the sake of comparability, we focused our analyses on planning practices with GIS and CAD.

First of all, it should be mentioned that GIS and CAD are not only designed for the performance of certain tasks by the planners themselves (e.g. spatial analysis, drawing), but that GIS and CAD practices of planners also involve the delegation of subtasks to non-human actors, for example in the form of automated calculations or visualisations. This can be understood as distributed action (Rammert & Schulz-Schaeffer, 2002). The functional logic of digital tools (based on code and algorithms) and their material design and texture relate with the way these tools can be used in planning. Because this affects planning practice and planning processes, one has to look at the techno*logics* as well as at the techno*textures* of digital tools: *Logics* are used to refer to the dimension of functional and operational modes and *textures* emphasise the materiality of technology. They may enable or constrain certain dimensions of embodied practices and the creation of spatial knowledge. And they have changed the previous way of spatial planning.

4.1. CAD as embodied practice

A whole set of material tools for drawing plans – ink, paper and the light table – has largely disappeared from the planning office. The tool for "drawing" is now the computer and the screen its surface. It is mainly CAD software that is used to construct ideas and visions of urban futures and for design planning (Mélix & Singh, 2021). They have become a prerequisite for planners to be involved in the planning scene at all. This has to do with the fact that clients increasingly ask for planning products in a digital form. Within this digital/analogue hierarchy it is the PDF, drawing and shape files that stand above printed brochures or plotted plans which are no longer demanded. Only on certain occasions do planners resort to analogue techniques. They draw by hand with pen and paper to make small quick sketches, to visualise initial ideas or to explain something to colleagues in a personal conversation. On the basis of our empirical research, we will analyse here how CAD software is used in the planning context and to what extent this corresponds to the functional and material properties of the tools.

Practices adapt to the devices, interfaces and command structures of the CAD programme, i.e. the technical tools become embodied, so to speak. The computer mouse is preferred to the keyboard – which was not always the case until the 1990s. You had to control the software via line-based input, which is a reason why CAD software for drawing only became popular with the introduction of the computer mouse. These "techno*textures*", closely linked to use, raise the question of *how* technologies are incorporated and to what extent the material nature of the tools' surfaces enables certain practices, and modes of mobility and communication. The material techno*textures* and functional *logics* of digital tools suggest the processing of certain tasks and are particularly well suited to certain positions of planners. For example, the touch-sensitive surface of a tablet, the touchscreen, enables quick, simple line drawings and a haptic immediacy between finger and drawing surface. According to planners, neither tablets nor laptops replace established design practices on desktop computers and with large, high-resolution monitors. Their functioning (that of a computer) and materiality (handy, battery-powered) make them particularly suitable for project managers who can use them to work from different locations and on the move. Project managers are less concerned with the production of details of final design products and renderings, but rather with communicative tasks, such as assigning and distributing tasks, commenting, evaluating, deciding, and presenting. They benefit from a tool with which they can add comments and mark-ups to digital image files and roughly sketch concepts that later serve as instructions to others for the construction of visual products.

The logic and texture of a digital tool afford and hinder certain social and spatial arrangements of tasks and bodies. Where the tablet invites project managers to engage in mobile practices, designers sit almost motionless in front of the large monitors at their desks. The analytical value of techno*logics* and techno*textures* lies in recognising the socio-spatial implications of tools in their material and operational dimensions.

The way programmes and tools are used is based on existing techniques. Software developers try to imitate them. Drawing programmes, such as *Mental Canvas*, are used via touch-sensitive tablets. Their design allows to create CAD images that look like hand drawings and are supposed to look different from the accurate style of technical drawings in other programmes. These are, as one designer explained to me, "sketchier" and less precise. Moreover, in their physical execution they are more comparable to paper and ink. The purpose of more abstract representations of designs is to make it easier to discuss plans and visions with clients and stakeholders as one does not get lost in discussing small details of a perfectly rendered visualisation. Where digital tools put their aesthetic stamp on visual constructions, the question of authorship arises. Conclusions can be drawn from the visual products about the programmes used.

[1] The differences we found were mainly related to the Lagos case. Firstly, financial aspects still play a role there due to the high acquisition and maintenance costs for digital tools. Secondly, in order to use GIS, the mega-city first has to fundamentally record spatial conditions, map them and build databases, which is why there is a lot of interest in drone technologies and data collection, whereas in the USA and Europe, efforts are aimed at networking existing databases and improving them. Certain differences in the practices with GIS and CAD were - as we found out - also dependent on the position or the educational background of a planner (draughtsman, programmer), his/her experience with the systems or his/her embedding in more nationally or globally operating planning institutions. These differences cannot be explored in depth in this paper due to lack of space. In the following, they can only be hinted at here and there in the article. For more detailled information see Schinagl (2022).

When they are used, programme-specific representational logics may be inscribed in the aesthetics of an image.

If one looks merely at the physical appearance of planning actions in CAD use compared to manual drawing, one notices that what planners do is mainly clicking and typing. The logic of digitalisation as a connection from point to point (P2P) continues in drawing, via mouse commands or the input of coordinates – and not by drawing a line. The drag-and-drop function of objects and elements allows geometric bodies to be moved back and forth, created, edited and changed again. With these physical actions, designers engage with the materiality and texture of surfaces and software. Alongside the imitation of established drawing techniques – such as hand drawing – new digital techniques are thus added. These include the ability to zoom in and out of an image file, not least when it consists of polygons.

Compared to CAD programmes, the way of putting thoughts on paper by hand and pencil is different and is perceived as more direct, which is why hand drawings continue to be included in the design process alongside CAD drawings. Many planners, especially designers – those who work with CAD programmes – are critical of this "socio-technique" (cf. Rammert & Schulz-Schaeffer, 2002) of zooming in and out when using design programmes. Drawing with computer-aided drafting programmes (CAD) differs from the analogue techniques of hand drawing due to the material and technical logics of action. The scale references are produced in a different manner. Planners now can "indefinitely" zoom in and out, and determine where exactly two lines shall cross. This may be at odds with the more or less implicit goals of some actions, which are about a quick sketch. The idea of "getting lost in scale" and working too closely on the small details is related to a fear that planners risk to get distracted from their original goal.

The use of technology creates a tension that contradicts the expectations of some planners. The way of drawing and use of technology correlates with the processes of constructing images and designerly ways of knowing (cf. Cross, 2006). What is made possible by the use of the tools, namely, to draw with computational precision and also to increase the complexity of planning products and processes will be shown in the following section.

4.2. GIS as data platform and the creation of spatial knowledge for planning

Numerous tools are used for spatial analysis in planning. Depending on local policies and the existence of and access to geo-data infrastructures, various map services or drone technologies are popular among planners. These help to visually document streets and places from distance and to virtually walk through, thus partially replacing site visits. Planners may a) experience a place in a sensory-physical way by their bodily presence as well as in direct communication with e.g. residents in site visits. They may b) gather and share information in communication with others throughout the planning process (e.g. in meetings) or by c) numerically generated, discretised, quantified, assembled and visualised geo-data via scripts (codes and algorithms) in simulations, graphics, tables and maps by means of complex digital tools.

The latter also include GIS. Used in conjunction with databases, GIS is used to collect, analyse and relate georeferenced information. However, GIS – like any technical system – is more than a technical system. It consists of various human and non-human parts: databases, software, hardware, networks of computers and servers in which data are exchanged and extracted, certain application and management procedures, and people, i.e. users. GIS is therefore best understood as a web of relationships, a platform or network of users and providers of spatial data. As in CAD, data in GIS is structured by so-called layers. Layers are processed information that is georeferenced and visualised over a base map. Layers are a paradigmatic artefact for digital planning practices. They are a key instrument for constructing spatial knowledge. With different layers, different data originating from different actors and institutions are brought together and made translocally available (Christmann & Schinagl, 2022).

Together with other programmes, GIS is useful to get a picture of a place. The overlay of data and information enables the analysis and interpretation of complex spatial orders and dynamics. In general, with regard to the digitalisation of many processes and procedures in planning, it can be said that planners can save themselves a lot of walking. At least when the corresponding data is sufficient. Planners can gather all sorts of (geo) information from their desk. They rely on various map services, find the necessary written documents on the internet and download the geo-data, which they visualise in GIS. In this way, they assemble a coherent picture of an area and derive settlement patterns, economic structures, social developments of recent decades and landscape markers of a natural or built nature in layers. Appropriate (intensive) preparation of databases and datasets can be of immense importance for the use of GIS as an instrument for constructing spatial knowledge, for the establishment of meaningful relationships of spatial data (geo-data) and for the creation of plans. Layers are processed information that is georeferenced and overlaid on the spatial representation of a map. As already said, they bring together different data originating from different actors and institutions that have collected, processed and provided them in different quality and collection methods. Compared to the translocalised use of GIS databases, local contexts are largely decisive for the construction of GIS databases. They are highly dependent on local technical and social infrastructures, resources, skills and the cooperation of the different actors. Like hardly any other digital planning tool, GIS presupposes institutionalised relationships between actors in specific locations. GIS is based on a division of labour and cooperation. In order to use it in a meaningful way, it depends on local contexts and socio-spatial relationships: for compiling spatial knowledge about places with constantly updated databases requires the networking of actors at different levels (national, regional, local). Local actors such as planning offices can be drivers in the development of geo-databases and thus platform-like networks. One example is the geoportal of the *FrankfurtRheinMain* Regional Association, which networks various local and regional actors, including Frankfurt's urban planning authority, to provide geo-data, maps and various map services. If there are only few geo-data inventories on places and few possibilities to create them, this ultimately also reduces the usefulness and possibilities to work meaningfully with GIS software.

5. Digital data, datafication, algorithms – the working basis of planning

What we should also mention here is that digital designs made with CAD software programmes such as Rhino, Grasshopper or AutoCAD by people who have not fully mastered the software cannot hide which programme they were made with. If the software is not mastered, there is a danger that its logic will dominate the planning design and significantly shape the planning product. The same applies to work with GIS and the layering of spatial data. There, the results depend very much on the quality of the spatial data fed in and on the algorithms inherent in the programme. This should prompt us to briefly consider what we actually mean by digital data, datafication, and algorithms and what significance they have in planning processes.

Spatial planning is typically based on digital spatial data and their interconnections. *Digital spatial data* are numerical georeferenced representations of the complex material and social dimensions of spaces. Typically, they reduce the phenomena they represent, as they can basically only consider individual aspects of the phenomena. This means that only certain aspects of reality are included.

The term *datafication* describes the phenomenon that dimensions of spatial realities enter computer worlds in the form of these digital data and are digitally processed and structured from there. It should be borne in mind that datafication inevitably leads to "aspectual abstractions" (Häußling, 2020, p. 141) of spaces due to the selectivity and reductiveness with which digital data represent spatial realities of directly experienceable material and social space. The question therefore arises as to which aspects are taken into account in digital representations and which are not – and what consequences this will have for planning.

There is another phenomenon: the large amount of data does not in itself produce meaning. Rather, it is the software, with the *algorithms* it contains, that searches for patterns in the data. Algorithms evaluate data by processing the decision routines programmed into them for this purpose. However, the underlying decision routines can only be understood by users with great difficulty. The sociologist of technology Häußling (2020, p. 144) therefore points out that with the use of digital tools, actors de facto decide to delegate their "decisions to technical instances, i.e. to no longer decide themselves, but to come to terms with the decisions that are delivered algorithmically". Against this background, we must state that the solutions for urban spaces devised by planners are always co-constructed and shaped mechanically by algorithms and their non-transparent decision-making structures. Strictly speaking, we must therefore observe a loss of control by the actors in the creation of planning solutions for urban spaces. It is true that losses of control have long been known in the field of planning, taking place within the framework of complex political-administrative as well as economic processes. Now there is a threat of further losses of control due to digital technologies.

6. Translocal planning processes

As already mentioned, planning processes in times of digitalisation are typically characterised by a multitude of data and communication practices. It is striking that almost all tasks in the planning process and in the communication between team members essentially consist of dealing with digital data. The tasks can be described as creating, collecting, sending, presenting, editing, providing and sharing data. On the one hand, software programmes for this promise efficiency gains, for example through the automatic creation of drafts and through functions such as drag-and-drop, copy-and-paste, moving objects, editing and undoing changes. As a result, individual planners can now work on several projects at the same time. Long-time project managers of smaller planning offices said that in recent years they have coordinated more and more projects at the same time without the teams or offices getting bigger. "*Ten or 15 years ago, an office of our size would not have been able to do that*" (Florian, NYC, 15.05.19).

However, as the application of the systems enables more complex planning products, the demand for such products, for example for high-quality renderings to visualise possible spatial designs of planning projects in an increasingly sophisticated way, is growing immensely. For this reason, certain tasks are delegated to different actors, possibly at different locations. For the composition of planning teams and the fulfilment of planning tasks, it is common today that they are distributed among different offices. Accordingly, planning practice often does not take place in only one planning office. Rather, planning projects are organised and networked translocally, i.e. in a division of labour and across locations. The digitalised division of labour and planning processes entails not only a methodology of data distribution but also the emergence of topologies of distributed and networked planning between actors across different locations (referred to as 'translocalisation'). Incidentally, as our research showed, it is a challenge that in this process team members sometimes even plan urban spaces that may be far away from them and of which they have no direct experience. Concerning specific sites of the planned spaces these infrastructures and digital planning practices allow for a mainly "technicised" construction of spatial knowledge through GIS and digital map services which is quite different to walking through parts of a site, receiving impressions and visualising spatial information through physical presence. The analogue spatial constructions of the planners always include a socio-cultural abstraction, but it is not an automatically synthesised abstraction. Against this background, we presume, that a lack of direct interaction with the spatial and cultural contexts of planned spaces lead to more standardised and streamlined planning outcomes.

From a socio-technical point of view, the smoothly linked data practices between different actors require material, technical and institutional infrastructures – be it shared server structures, VPN tunnels, cabling as well as trusting and intensive communication between planners for data exchange.

A typical example of these developments is that of Kohn Pedersen Fox (KPF), founded in New York City in 1976. Today, more than 700 employees work at nine locations in the northern hemisphere, including London, Shanghai, and Berlin. This enables continuous processing of projects over time. The locations of the planning projects and the planning areas are distributed worldwide and include sites in the "global south". The planning office works internationally or globally, and its actors act across locations as if they were "one" office. The ease with which distances and locations seem to play no role can only hint at how well the complex infrastructures and practices intertwine. Planning practices that rely on digital infrastructures enable a wide reach of planning offices' projects. This applies both to large, translocalised networks of planning offices operating on a global scale as well as to independent niche providers. Global players with up to several thousand employees may coordinate complex and capital-intensive projects and project teams at different locations better than smaller planning offices operating on a local and regional level due to matured infrastructures. This does not hide the fact that the networking of planners at national, regional, and local level is also taking place in smaller-scale contexts, even networking within one office is being promoted.

However, if one depicts in a simplified and abstracted way the cases of the planning offices investigated in our study with their branch offices and project locations on a world map (see Fig. 1), it becomes clear how planners can be active worldwide due to their digitalised work contexts. The spatial pattern shows networked and far-reaching activities and thus a global distribution of planning practices.

It should not go unmentioned, that spatial disparities become apparent at the same time. Fig. 1 shows for example that there are no global players from Lagos and that the offices there mainly limit themselves to regional planning projects (cf. *Toyin Ayinde Associates* in Lagos). The North-South divide visible here and mentioned in numerous interviews leads to the conclusion that what digitalisation in principle enables in planning practice is not equally distributed among planning offices and actors worldwide. The digitalisation of planning practices per se cannot therefore simply bridge dominant, partly hegemonic power structures and inequalities at the global level.

Individual planners still depend on the structure of institutional and infrastructural relations in which they are involved. The places and positions from which planners act are relevant and determine to a certain degree which technology, tool and publicly accessible geo-databases can be used. In New York for example, the use of geo-information systems for projects is predestined for this, as there is an almost inexhaustible amount of publicly accessible geo-databases to fall back on. In Lagos, which does not possess this luxury, many planners resort to drones to collect up-to-date aerial data – something that in New York again is reserved only for highly specialised providers due to the strict regulations of NYC's airspace.

Digital planning is thus data-based and datafied planning. In the course of a working day, a planner can be in different spatial contexts depending on the project context and the task at hand, without having to leave his or her own workplace. However, the planning processes located in digitalised and translocalised planning practices also materialise in the shape of planners' workplaces and planning offices, which have also changed in the course of digitalisations. In the next section, we therefore zoom back to the level of situated practices and look at the material spatial structures of (digitalised) planning workplaces and spaces.

7. The re-arrangement of workplaces and planning offices

The arrangement of workstations, the layout of offices and the locations of planning reflect the technicised relationships between planners and the expectations placed on them. Looking at the different planning workplaces and offices at our various research locations, we find similarities between them and to other industries: Planning offices look quite similar to those of start-up companies or other offices of sectors that rely heavily on computer work. A typical working day in planning offices consists of working at the computer. Many practices consist of clicking and typing, not unlike other office jobs.

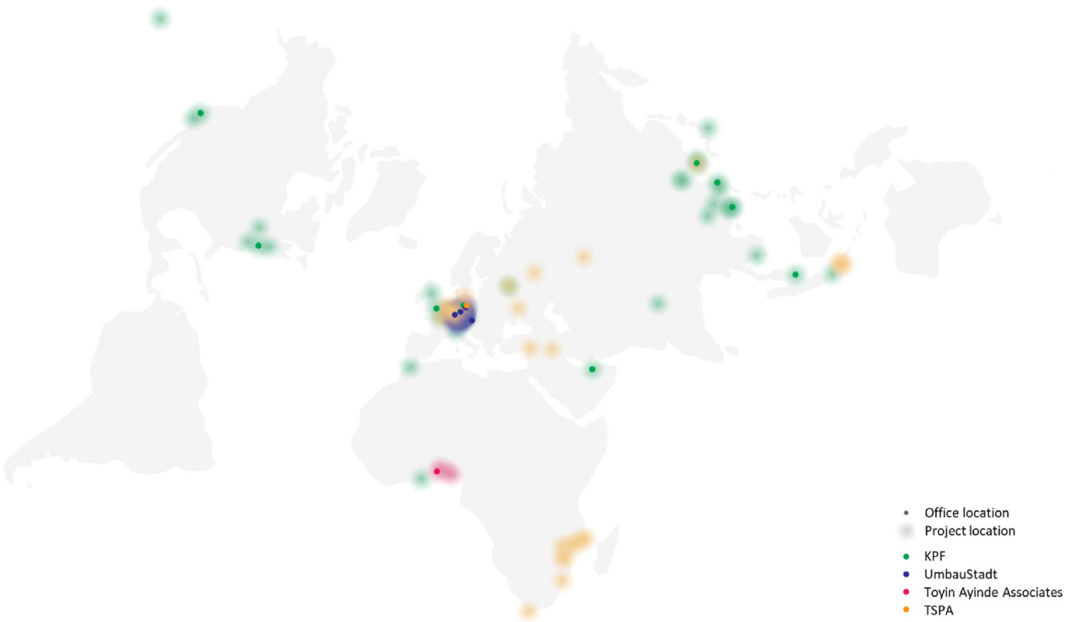

Fig. 1. Office and project locations of selected planning offices: Kohn Pedersen Fox (KPF), New York (green), UmbauStadt, Frankfurt/Berlin (blue), Toyin Ayinde Associates, Lagos (red), Thomas Stellmach Planung und Architektur (TSPA), Berlin (yellow). Visualisation: Niklas Kuckeland. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

The smallest unit is the *workplace* with the desk. The use of the desktop computer or laptop is the primary focus of many individual workplaces; meaning that other activities, such as manual drawing, and face-to-face communication, are given a secondary role or done elsewhere. Workplaces are arranged through a more or less meaningful arrangement of things based on both collective conventions and individual choices. The arrangements can thus be studied as an expression of the conventions embedded in a particular profession or professional position and of individual practices. Fig. 2 shows the arrangement of a typical workplace, in this case of an urban designer in Berlin, which mainly consists of computer hardware equipment and classic office supplies.

When comparing individual workplaces, differences and similarities stand out: for example, the workplace of a designer collecting information about a planning area is quite different from that of a 3D visualiser. The former uses pens and notepads for doodles, notes and small calculations and sets aside stacks of literature and folders. When visiting an office, the visualisation specialist's workplace appeared relatively tidy and empty, comprising only the computer on the desk. This person takes on very specialised and limited spatial-analytical or, in the narrower sense, planning tasks.

Planning offices are the next largest spatial unit. There, the individual workplaces are spatially interrelated. Planning offices usually consist of different rooms. It is thus divided into sub-spaces, which are occupied with functions (communication, design, archiving, relaxation, etc.). Here, too, digitalisation processes have brought effects in the form of physical-material changes. One of the most important changes, for example, is that with the computer, the drawing table has been displaced (and with it, incidently, the technical draughtsman, who previously sat in a separate drawing room).

From the empirical material and the impressions gathered in the planning offices of the various locations studied, typical office forms for planning offices can be distinguished, which also occur in mixed forms: open, closed and nomadic office type forms. (i) The open office is intended to have an impact on the communicative dynamics of the workforce. Characteristic is the openness of the spatial environment, which should create incentives for cooperation and communication. It should promote communication in planning processes and encourage creative solutions. Marguin, Pelger, and Stollmann (2021) investigated in so-called “experimental zones” how flexibly open office arrangements can be handled and what communicative effects result from different forms of arrangement. After all, workplaces can be changed, redesigned and reassigned. Teams can rearrange and implement themselves depending on the project context. This office type form is dominant among private planning offices. (ii) In closed offices, in contrast to the large spaces of open offices, only one or a handful of planners work in a kind of “cells”. They are divided by partitions, the rooms are assigned to clear persons or positions and intended for specific functions. This type of office space is dominant above all in bureaucratically structured planning offices or planning departments. (iii) The nomadic office space is characterised by deterritorialisation, i.e. it is not assigned to a specific team, an individual planner or a specific function. A workspace is rented individually and only occupied in phases. This spatial concept allows a more flexible way of digitalised working. The office is where the laptop is. It is often external or freelance planners who work in this kind of working environment.

Fig. 2. Workplace of an urban designer and list of individual objects on the table: pieces of paper, keyboard, disinfectant spray, sticky notes, notebooks, stack of paper, eraser, ruler, box, pens, calculator, tube, monitor, plants, transparent paper roll, vial and an adhesive tape. Visualisation: Niklas Kuckeland.

Despite all the differences in the various planning offices, one room is found in all the locations and office types studied: the conference room. Large or small, this room is highly standardised: typically it consists of a centrally placed table, a number of chairs corresponding to the size of the room and a large monitor on the wall, which is usually also the largest in the office. This is where individual planners or entire teams retreat for meetings to engage (in direct exchange or via video telephony) with other members of the planning team, stakeholders, journalists, etc. Furthermore, it should not go unmentioned that due to the fact that the digital work of planners - as a result of the comprehensive datafication and the associated very high data volumes (not least in connection with high-quality visualisations) - requires digital infrastructures such as servers. Server rooms have also become part of planning offices, which in turn require special “working environments” in the form of cooling or ventilation.

8. Conclusions

The extensive datafication of a wide range of spatial dimensions and the growth of digital data volumes have a significant impact on the work of planners and entire planning teams: they are typically busy with creating, collecting, researching, further processing, controlling and sharing data. The kinds of data involved are diverse and highly complex. Planners have to process more aspects of space than ever before – this is a task that could hardly be managed without the use of digital planning tools. These tools include software programmes such as GIS and CAD, which bring increased requirements for the fulfilment of planning tasks and the creation of planning products, resulting in a considerable intensification of the work process. Traditional planning practice still exists but is being increasingly permeated by digital forms.

Furthermore, it can be observed that data-supported planning processes are often carried out translocally between members of a team who may be distributed spatially (worldwide). Planners network and connect beyond a single place of action via digital infrastructures like computers, servers, databases, including information and communication technologies. In the context of digitalisation it is noticeable that the physical workplaces and planning offices have been materially and spatially realigned. In light of these developments, according to Knoblauch and Löw (2020), one can rightly speak of a “refiguration”, i.e. a fundamental transformation of forms of work as well as work spaces.

One challenge for urban planning, as shown in the article, is that we are witnessing a comprehensive digital datafication of spatial realities as the central starting point for planning activities and that at the same time an increasing translocal work of planning actors can be observed. As a consequence fewer and fewer members of the team know the urban spaces to be planned from first hand experience. They rather rely on databases. In addition, algorithms are involved in the planning process, whose decisions and influences are only transparent to the planning actors in a limited form. We have therefore spoken of a loss of control through digital planning.

So on the one hand, we have to lament certain losses in the context of digital planning processes, because purely socio-material dimensions of spatial realities lose significance. On the other hand, we can also identify and use new opportunities and gains through digitalisation and datafication. Material and social spaces do not disappear, even if they take on a different significance. Rather, digitally represented spaces are added through datafication. From the perspective of the sociology of technology, this does not result in a doubling of spaces. It is therefore not a question of a juxtaposition of socio-material spaces on the one hand and datafied spaces on the other. Rather, 'couplings' (Häußling, 2020, p. 135) of these spaces can be identified, since they are interlocked in human action, which is oriented towards both forms. In the digital age, hybrid spaces have emerged and become part of our new realities. Our perceptions of space can thus be expanded in new ways and offer us new orientations. This also applies for planning practices.

In the future, thus losses and gains must be brought into a good balance. This requires, firstly, a highly reflexive and competent use of digital technologies in planning. Secondly, it will be necessary in the future to make machine decisions of digital planning tools more visible and controllable. And thirdly, it has become more important than ever to involve stakeholders and citizens, whose requirements for spaces must always have priority.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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References

Adeoye, A. A. (2010). *Lagos state geoinformation infrastructure policy (LAGIS) as a tool for mega-city development*. Sydney: Paper presented at the *FIG Congress 2010 Facing the Challenges – Building the Capacity*. April 2010.

Al-Kodmany, K. (2002). Visualization tools and methods in community planning. *Journal of Planning Literature, 17*(2), 189–211.

Assarkhaniki, Z., Sabri, S., & Rajabifard, A. (2021). Using open data to detect the structure and pattern of informal settlements: An outset to support inclusive SDGs' achievement. *Big Earth Data, 5*(4), 497–526.

Billger, M., Thuvander, L., & Wästberg, B. S. (2016). In search of visualization challenges: The development and implementation of visualization tools for supporting dialogue in urban planning processes. *Environment and Planning B, 44*(6), 1012–1035.

Bindu, N., Prem Sankar, C., & Satheesh Kumar, K. (2019). From conventional governance to e-democracy: Tracing the evolution of e-governance research trends using network analysis tools. *Government Information Quarterly, 36*(3), 385–399.

Brail, R. (Ed.). (2008). *Planning support systems for cities and regions*. Cambridge: Lincoln Institute of Land Policy.

Visual communication in urban design and planning: The impact of mediatisation(s) on the construction of urban futures (special issue)Christmann, G., Bernhardt, C., & Stollmann, J. (Eds.). *Urban Planning, 5*(2), (2020).

Christmann, G., & Schinagl, M. (2022). Digital urban planning and urban planners' mediatized construction of spaces. In G. Christmann, H. Knoblauch, & M. Löw (Eds.), *Communicative constructions and the refiguration of spaces* (pp. 139–153). London: Routledge.

Craig, W. J., Harris, T. M., & Weiner, D. (2001). *Community participation and geographical information systems*. London: Routledge.

Cross, N. (2006). *Designerly ways of knowing*. Wiesbaden: Springer.

Czerkauer-Yamu, C., & Voigt, A. (2016). In A. Elisabete, et al. (Eds.), *Handbook of planning research methodsSpatial simulation and the real world: Digital methods and techniques in the context of StrategicPlanning* (pp. 348–363). London: Routledge, 2016.

Eckhardt, D., May, S., Röthl, M., & Tischberger, R. (Eds.). (2020). *Digitale arbeitskulturen. Rahmungen, effekte, herausforderungen* (p. 82). Berliner Blätter, 2020.

Falco, E., & Kleinhans, R. (2018). Digital participatory platforms for Co-production in urban development: A systematic review. *International Journal of E-Planning Research, 7*(3), 1–27.

Fang, Y., Shandas, V., & Arriaga Cordero, E. (2014). *Spatial thinking in planning practice. An introduction to GIS*. Portland: Portland State University Library.

Geertman, S., & Stillwell, J. (2020). Planning support science: Developments and challenges. *Environment and Planning B: Urban Analytics and City Science, 47*(8), 1326–1342.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. New York: Aldine.

Goodspeed, R., & Hackel, C. (2017). Lessons for developing a planning support system infrastructure: The Case of Southern California's Scenario Planning Model. *Environment and Planning B: Urban Analytics and City Science, 46*(4), 777–796.

Goodwin, C., & Goodwin, M. H. (1996). Seeing as situated activity: Formulating planes. In Y. Engeström, & D. Middleton (Eds.), *Cognition and communication at work* (pp. 61–95). New York: Cambridge University Press.

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575–599.

Häußling, R. (2020). Daten als Schnittstellen zwischen algorithmischen und sozialen Prozessen. *Konzeptuelle Überlegungen zu einer relationalen Techniksoziologie der Datafizierung in der digitalen Sphäre, 23*, 134–150. Soziale Welt.

Hepp, A. (2020). *Deep mediatization*. London: Routledge.

Hersperger, A. M., Grădinaru, S. R., & Siedentop, S. (2020). Towards a better understanding of land conversion at the urban-rural interface: Planning intentions and the effectiveness of growth management. *Journal of Land Use Science, 15*(5), 644–651.

Hersperger, A. M., Thurnheer-Wittenwiler, C., Tobias, S., Folvig, S., & Fertner, C. (2021). *Digitalization in land-use planning: Effects of digital plan data on efficiently, transparency and innovation* (pp. 1–17). European Planning Studies.

Hudson-Smith, A., & Shakeri, M. (2022). Gaming, simulations, and planning: Physical and digital technologies for public participation in urban planning (special issue). *Urban Planning, 7*(2).

Knoblauch, H. (2000). In I. Götz, & A. Wittel (Eds.), *Arbeitskulturen im Umbruch: Zur Ethnographie von Arbeit und OrganisationWorkplace Studies und Video. Zur Entwicklung der visuellen Ethnographie von Technologie und Arbeit* (pp. 159–173). Münster: Waxmann.

Knoblauch, H. (2005). Focused ethnography. *Forum for Qualitative Social Research, 6*(3). Art. 44 http://nbn-resolving.de/urn:nbn:de:0114-fqs0503440.

Knoblauch, H., Janz, A., & Schröder, D. J. (2021). In M. Löw, V. Sayman, J. Schwerer, & H. Wolf (Eds.), *Am Ende der Globalisierung. Über die Refiguration von Räumen. transcriptKontrollzentralen und die Polykontexturalisierung von Räumen* (pp. 157–182). Bielefeld.

Knoblauch, H., & Löw, M. (2020). The Re-figuration of spaces and refigured modernity – concept and diagnosis. *Historical Social Research, 45*(2), 263–292.

Krotz, F. (2007). *Mediatisierung. Fallstudien zum wandel von Kommunikation*. Wiesbaden: Springer.

Lange, E. (2011). 99 volumes later. We can visualize. *Landscape and Urban Planning, 100*(4), 403–406.

Lopes, C. V., & Lindström, C. (2012). Virtual cities in urban planning. The uppsala case study. *Journal of Theoretical and Applied Electronic Commerce Research, 7*(3), 88–100.

Lovett, A., Appleton, K., Warren-Kretzschmar, B., & Von Haaren, C. (2015). Using 3D visualization methods in landscape planning. *Landscape and Urban Planning, 142*, 85–94.

Marguin, S., Pelger, D., & Stollmann, J. (2021). Mappings als joint spatial display. In A. J. Heinrich, S. Marguin, A. Million, & J. Stollmann (Eds.), *Handbuch qualitative und visuelle Methoden der Raumforschung* (pp. 381–398). Stuttgart: UTB.

Mélix, S., & Christmann, G. (2022). Rendering affective atmospheres: The visual construction of spatial knowledge about urban development projects. *Urban Planning, 7*(3), 299–310.

Mélix, S., & Singh, A. (2021). Die visuelle Refiguration urbaner Zukünfte: Zur Prozessualität von digitalen Architekturvisualisierungen am Beispiel von Hudson Yards in New York. In M. Löw, V. Sayman, J. Schwerer, & H. Wolf (Eds.), *Am Ende der Globalisierung. Über die Refiguration von Räumen. transcript* (pp. 231–256). Bielefeld.

Müller-Arisona, S., Aschwanden, G., Halatsch, J., & Wonka, P. (Eds.). (2012). *Digital urban modeling and simulation*. Berlin: Springer.

Orr, J. E. (1996). *Talking about machines: An ethnography of a modern job*. Ithaca, N.Y: ILR Press.

Pinto, N. N., Tenedorio, J. A., Antunes, A. P., & Cladera, J. R. (2014). *Technologies for urban and spatial planning*. Hershey: IGI Global.

Rammert, W., & Schulz-Schaeffer, I. (2002). *Technik und Handeln – wenn soziales Handeln sich auf menschliches Verhalten und technische Artefakte verteilt*. Berlin: TUTS-Working Papers.

Rose, G., & Willis, A. (2019). Seeing the smart city on Twitter. Colour and the affective territories of becoming smart. *Environment and Planning D: Society and Space, 37*(3), 411–427.

Ross, M. (2012). The 3-D aesthetic: Avatar and hyperhaptic visuality. *Screen, 53*(4), 381–397.

Sabri, S., Chen, Y., Rajabifard, A., Lim, T. K., Khoo, V., & Kalantari, M. (2019). A multi-dimensional analytics platform to support planning and design for liveable and sustainable urban environment. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-4*(W15), 75–80.

Schillaci, F., Burelli, A. R., & Avella, F. (Eds.). (2009). *Architectural renderings: Construction and design manual*. Berlin: DOM.

Schinagl, M. (2022). *Digitale stadtplanung. Alltag und räume technisierten planens. Transcript*. Bielefeld (in press).

Shen, Z. (Ed.). (2012). *Geospatial techniques in urban planning*. Berlin and Heidelberg: Springer.

Silva, C. N. (2015). *Emerging issues, challenges, and opportunities in urban E-planning*. Hershey: IGI Global.

Stenslund, A., & Bille, M. (2021). In M. Stender, C. Bech-Danielsen, & A. L. Hagen (Eds.), *Architectural anthropologyRendering atmosphere* (pp. 207–223). London: Routledge.

Strauss, A. L. (1997). *Grounded theory in practice*. Thousand Oaks: Sage.

Suchman, L. A. (1985). *Plans and situated actions: The problem of human-machine communication*. Xerox, Palo Alto: California.

Yin, L., & Shiode, T. (2014). 3D spatial-temporal GIS modeling of urban environments to support design and planning processes. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 7*(2), 152–169.