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Is a new *Planning 3.0* paradigm emerging? Exploring the relationship between digital technologies and planning theory and practice

Abstract
In recent decades cities and urban planning have become increasingly digitised, complex and data rich. Despite this, the planning theory literature has largely ignored the role and impact of information and communication technologies in shaping planning's ontologies, epistemologies, and methodologies. This article explores empirical studies and three major planning paradigms to explore the changing role and influence of information and communication technologies on planning theory and practice. Based on this, the paper argues that information and communication technologies are driving a shift towards a more interactive, intelligent, self-organising, and interconnected planning paradigm.

Keywords: *urban planning, information and communication technologies, ICTs, technological turn, planning theory, communicative planning, planning 3.0, smart cities*

1.0 Introduction
Technology is now involved in practically every part of contemporary planning practice. Historically information and communication technologies (ICTs) have been applied in a relatively positivistic way by planners (Klosterman, 2013). However, in recent decades ICTs have opened up new ways of collecting and analysing data of urban systems and their populations, informing and making decisions, understanding a multitude of interests, and including stakeholders in the planning process (Gordon, Schirra, & Hollander, 2011). The growing diversity of ICTs (hardware and software) available to planners is enabling planners to better communicate, collaborate and consult, but also collect, analyse, and interpret large quantities of data, often in real-time (Stratigea, Papadopoulou, & Panagiotopoulou, 2015; Wilson, Tewdwr-Jones, & Comber, 2017).

While the body of literature exploring applications of various ICTs in a planning context is expanding (Wilson et al., 2017; Yigitcanlar et al., 2018), very few studies have critically questioned how the progressive integration of such ICTs into planning practice has influenced how planners think about, understand and approach planning issues. Studies discussing the epistemologies, ontologies and methodologies used in planning have also been limited in their discussion of ICTs, largely focussing on paradigmatic shifts or 'turns' planning paradigms (e.g. the communicative turn)(Healey, 1992; Rydin, 2014). Arguably, discussions of planning paradigms, and particularly the epistemologies and ontologies of broader planning paradigms have largely ignored the role of ICTs in planning. This represents a significant gap in the current understanding of ICTs impact on broader planning paradigms. This paper aims to fill the aforementioned gap in answering the following two questions:

1. How has the growth in ICTs available to planners influenced their ontologies, epistemologies and methodologies?
2. Has the impact of ICTs on planning as a discipline catalysed a transformation or 'turn' in planning paradigms?

To answer the above questions, Section 2.0 provides a brief overview of ICTs and their evolution. Section 3.0 establishes the conceptual framework for this research, defining the key elements of a paradigm, introducing key planning paradigms, and identifying three elements that constitute a paradigm shift. After this, Section 4.0 is structured using three dominant paradigms from the planning literature (rational/scientific, pluralism, and communicative planning). Section 4.0 uses the three paradigms as historical themes to organise the parallel discussion of the development of planning paradigms, and the evolution of ICTs and their use in planning contexts. Section 5.0 constitutes the primary theoretical contribution of this paper and argues that the introduction of ICTs has and continues to influence current planning paradigms. Drawing on evidence from the empirical and theoretical literatures it argues that ICTs are contributing to the emergence of fundamentally novel aspects of ontologies, epistemologies, and methodologies in the planning discipline. Reflecting this, Section 5.0 explores emerging trends in the planning and smart cities literature and argues that current developments suggest ICTs are driving a paradigm shift in planning. This is referred to in the paper as a shift to '*Planning 3.0*' and is argued to be distinctly different from previous planning paradigms, based on the reliance and use of ICTs to increasingly support a more interactive, intelligent, self-organising, and interconnected planning practice. The paper concludes in Section 6.0 with a summary of the key findings of the research, and recommendations for future research.

2.0 Understanding ICTs

The term ICTs is used to describe a broad range of digital software and hardware that enable users to collect, share, communicate and analyse information (Arthur, 2009; Price, Jewitt, & Brown, 2013; Selwyn, 2004). ICTs include (but are not limited to) computers (hardware and software), mobile devices, broadcasting, the internet, and telecommunications. ICTs have also become substantially more capable since the introduction of the internet to the public in the late 1980s, and the progressive developments of smaller, faster computer systems, and wireless access to the internet (Choudhury, 2014).

The evolution of the internet (or Web) can currently be broadly considered in three stages – Web 1.0, Web 2.0, and Web 3.0 (Table 1) (Berners-Lee, 2010; O'Reilly, 2007). The progression between each stage has involved increasing opportunities for individuals to connect, share, create, and network with other individuals and content, which itself has also become more mobile and integrated into everyday items (Aghaei, Nematbakhsh, & Farsani, 2012; O'Reilly, 2007). Access and use of such internet-enabled ICTs have arguably become a ubiquitous 'part of the toolkit necessary to participate and prosper in an information-based society' (Servon & Nelson, 2001, p. 279). Web 4.0 and 5.0 are still emerging, but represent further evolutions of these concepts, encapsulating greater levels of mobility and integration of ICTs with everyday objects and experiences, as well as ICTs enhanced for emotional awareness of users (Aghaei et al., 2012; Palti & Bar, 2015). However, as Web 4.0 and 5.0 are relatively speculative in nature at the time of writing this article, this article focusses on linkages between planning and Web 1.0 to 3.0.

Table 1: The evolution of the World Wide Web from Web 1.0 to Web 3.0

	Web 1.0	**Web 2.0**	**Web 3.0**
Format and flow of information	Read-only (one way)	Read and write (two-way)	Semantic (multidirectional)

Approximate time frames	1989-2004	2004-2010	2010-present
Content	Static content	Dynamic/interactive content	Peer to peer connectivity of content (decentralised content)
Focus	Providing information	Connecting people	Connecting information and people
Personal Data	Limited sharing of personal data	Shared and tied to accounts with different service providers (e.g. A social media account, a supermarket, etc). Providers can share personal data with partners	Control of personal data is decentralised to users. Users control their own data and who has access to it.
User capacity	Read content on centrally hosted public websites	Read and modify content on centrally hosted publicly accessible private networks	Cooperative with other users to co-create, share, and modify content. Users are also data points whose behaviours can be interpreted rapidly by artificial intelligence for meaning and interpretation.
Mobility	Static (Desktop Computers)	Static and mobile (laptops, mobile phones, tablets, and desktop computers)	Integrated into 'things' mobile and static (computerisation and making daily life 'smart').
Associated ICTs	Websites, email	Social networks, blogs, video and image sharing, wikis, virtual worlds, widgets,	Artificial intelligence, automated reasoning, machine learning, cognitive architecture, semantic web, cloud database storage, smart devices, augmented reality, virtual reality, sensors, location-based services,

Based on: Prabhu (2017), Newman, Chang, Walters, and Wills (2016), and Choudhury (2014)

As shown in Table 1, each stage has a distinct set of characteristics demarcating it from the previous and subsequent stages of Web evolution. The conceptual boundaries between each stage are somewhat blurry and overlapping, with each progression absorbing the progress of the previous stage (Choudhury, 2014). Web 3.0 seeks to semantically link big quantities of data, making the information readable by machines, therefore making the outputs of Web 3.0 more meaningful to users than those of Web 1.0 or 2.0 (Antezana, Kuiper, & Mironov, 2009; Berners-Lee, Hendler, & Lassila, 2001). For example, Web 1.0 and 2.0 provided citizens with access to individual sets of information across multiple websites (e.g. the location and prices of available rental properties, public transit accessibility of a neighbourhood, availability of amenities and social infrastructure in an area) that they must then self-interpret to determine where in a city they should live (Berners-Lee et al., 2001; Fuchs et al., 2010). Web 3.0, on the other hand, uses algorithms to amalgamate information into useful groupings, enabling the user to more meaningfully answer their question regarding the overall liveability of an area, without needing to undertake numerous and time-consuming web searches for each piece of information (e.g. see the Urban Living Index at https://urbanlivingindex.com.). The broader hallmarks of Web 3.0 are interoperable, mobile, and 'intelligent' or 'smart' ICTs capable of reading, comprehending, connecting, and applying information collected from the internet for specific user needs (Garrigos-Simon, Lapiedra Alcami, & Barbera Ribera, 2012).

3.0 Conceptual Framework: Paradigms and Turns

A paradigm is a set of assumptions that are agreed upon and frame the discussion of ideas within a discipline (Kuhn, 1962). Paradigms encompass both theory and practice, and include how knowledge is understood (epistemologies), the methods used to gain and apply that knowledge (methodologies), and the overarching worldview(s) evident within a discipline (ontologies)(Guba & Lincoln, 1994). In a physical science context, Kuhn (1962) argued that the existence of multiple and competing paradigms in a discipline suggests disciplinary immaturity, whereas more mature disciplines will share a single or dual set of paradigms. Scholars in the social sciences, however, argue that multiple paradigms can coexist in a discipline and are reflective of the diversity of specialities in researching societal dynamics (Eckberg & Hill Jr, 1979; Shepherd & Challenger, 2013).

The term 'turn' is used in academic literature to refer to a 'concerted reorientation' in a disciplinary paradigm, approach and broader focus (Ash, Kitchin, & Leszczynski, 2018, p. 10) and is based on the idea of a Kuhnian epistemic paradigm shift (Kuhn, 1962). Paradigm shifts occur when factors arise in a discipline that are incongruous with or cannot be explained by the existing paradigm, triggering a need to reconsider the core assumptions of the core disciplinary approaches (Sheller & Urry, 2006). In the planning literature the term turn has been used to 'identify a change in direction and emphasis in planning theory…[and] a reorientation… [in] understandings of planning activity' (Harris, 2005, p. 25).

Planning paradigms have historically been in a state of flux, with the planning literature describing several paradigms and the turns and tensions between them in the last half-century. These include but are not limited to the rational scientific paradigm, the pluralistic planning paradigm, the 'communicative turn' (Healey, 1992, 1996; Innes, 1995), the 'argumentative turn'(Hajer, Hoppe, & Jennings, 1993), the 'story turn' (Sandercock, 2010), the 'material turn' (Rydin, 2014), and the 'Southern turn' (de Satgé & Watson, 2018; Watson, 2016) in theoretical conceptualisations of planning practice.
Each of these paradigms represents a distinct set of ontologies, epistemologies and methodologies. The development of these paradigms has occurred simultaneous to the evolution of ICTs (See Figure 1), suggesting a need for analysis of where these two timelines have interacted, and an exploration of their influences on each other. Relative to evolutions in ICTs we could consider the rational planning paradigm as 'Planning 1.0', and the emergence of pluralistic planning approaches and the communicative paradigm as 'Planning 2.0' given their dominance in planning theory texts.

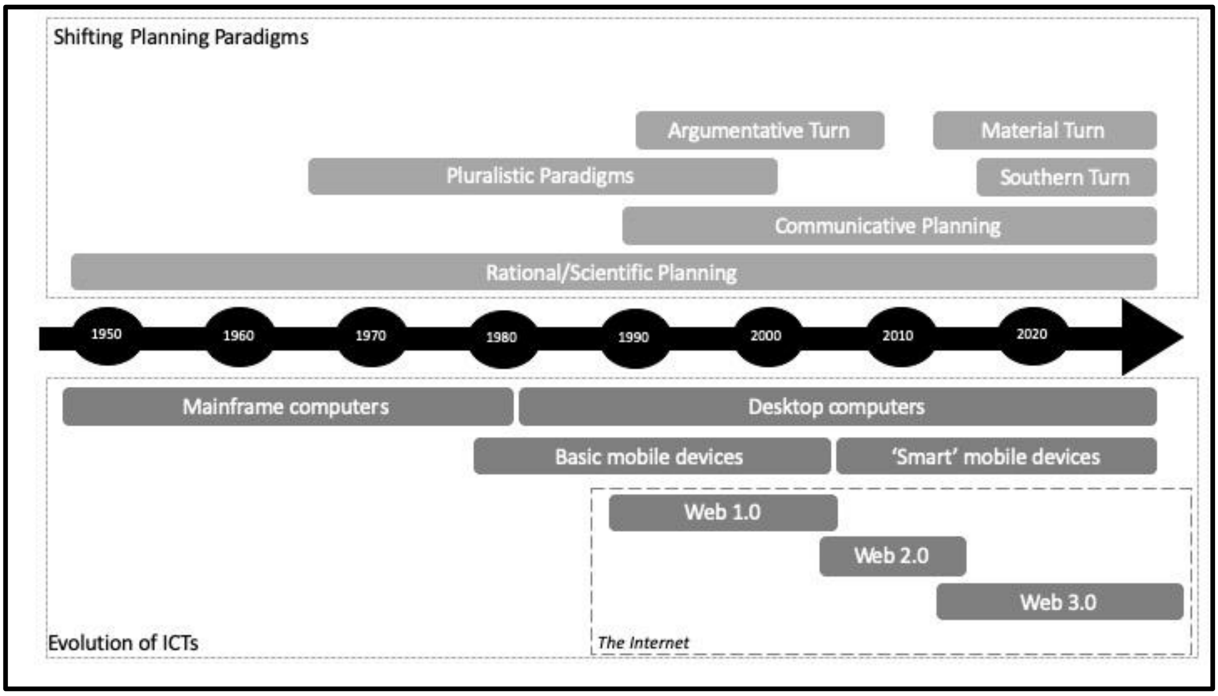

Figure 1: The parallel timelines of the development of planning paradigms, and ICTs 1950-2030
Sources: (Berners-Lee, 2010; Davidoff, 1965; de Satgé & Watson, 2018; Friedmann, 1993; Healey, 1996; O'Reilly, 2007; Prabhu, 2017; Roy, 2009; Rydin, 2014; Scott & Roweis, 1977; Watson, 2016; Wildavsky, 1973)

Building on the discussions of 'turns' in the planning and wider literatures (Allmendinger & Tewdwr-Jones, 2002; Ash et al., 2018; Healey, 1992; Rydin, 2014), and paradigm shifts by Kuhn (1962), this paper postulates that a 'turn' can be identified by the presence of 1) an increased ontological and theoretical emphasis on an idea/concept, 2) an increased application and use of methodologies relevant to an idea or concept, and 3) an influence on 'the ways in which knowledges are constructed, communicated and debated' (epistemologies) (Ash et al., 2018, p. 11) in a discipline. This research draws on the above characteristics to structure its assessment below to determine whether the impact of ICTs has catalysed a 'technological turn' in the planning discipline or whether technology is simply a constantly evolving tool used by planners.

4.0 Evolving planning paradigms and ICTs

Planning theorists have postulated for decades how best to conceptualise and explain what exactly planning is, how planners should understand knowledge, and critically reflect on the practice of planners (Davidoff, 1965; Faludi, 2013; Healey, 1992; Wildavsky, 1973). While there is an expanding body of literature on ICTs relevant to planning practice, planning theorists have only recently begun to discuss how different types of ICTs might be considered in the context of planning theory and practice, and their influence on and by planning paradigms (Anttiroiko, 2012; Silva, 2010). To understand whether the growth in ICTs available to planners has influenced their ontologies, epistemologies and methodologies, three key planning paradigms from the literature are explored chronologically, with particular focus on how ICTs are discussed in each paradigm's corresponding body of literature.

4.1 The Rational Planning Paradigm and ICTs

Planning was framed as a rational and applied spatial science largely undertaken by local government planners in the 1950s and 1960s (Davoudi & Pendlebury, 2010; Faludi, 2013), echoing what Guba and Lincoln (1994, p. 109) call a positivistic, 'naïve' realist ontology. Under this ontology, planning was seen as a primarily physical (as opposed to social) discipline and theorists argued that 'spatial problems should be framed as scientific problems, articulated through spatial interaction models, and tackled through the science of systems analysis and control' (Davoudi & Pendlebury, 2010, p. 624). Spatial problems in this paradigm were generally considered through the lens of immutable and quantifiable urban principles, and assessed based on quantitative summations of urban issues (Davidoff, 1965; Faludi, 2013). Some planners applied early forms of computer modelling of complex urban systems, as well as policy frameworks, and general urban planning principles to inform an 'objective' analysis of alternative ways of efficiently achieving plan goals, and decisions about land uses, infrastructure, and other spatial issues at various scales (Dalton, 1986).

There is limited evidence to suggest ICTs influenced planning ontologies, epistemologies or methodologies in the 1950s and 1960s. During this period (and indeed for some up until the late 1990s), planning practitioners and academics would have been familiar with pre-ICTs and non-internet and non-digital office technologies such as typewriters, overhead projectors, and landline telephones. ICTs, on the other hand, were considered an advanced methodological tool to access, analyse and communicate spatially-referenced and other forms of largely quantitative data to inform decision-making (Geertman, 2017; Klosterman, 2013). Mainframe computers and early forms of GIS also enabled planners to digitise some of the work that they had previously done by hand (e.g. mapping and spatial analysis). The sophistication, availability, uptake and applications of such technologies however, was generally low and uneven in practice and research (Klosterman, 1992; Klosterman & Landis, 1988; Lee, 1973; McLoughlin, 1969; Whited, 1982). Arguably, the emerging technologies largely did not change fundamental conceptualisations of the profession, or the types of tasks planners of the time were engaging in, but rather changed the format in which they were presented.

4.2 Pluralistic Planning Paradigms and ICTs

The 1970s and 1990s saw the emergence of more post-positivistic, post-modern, and pluralistic planning paradigms, reflecting a growing discontent and inability of positivistic planning paradigms to account for the personal values, complexities and realities of planning practice (Forester, 1988; Lee, 1973; Scott & Roweis, 1977; Wildavsky, 1973). New paradigms framed planning practice variously as incremental (Wildavsky, 1973), advocacy (Davidoff, 1965), mixed-scanning (Etzioni, 1967), transactive (Friedmann, 1993), and diverse and political (Forester, 1988). While some of these (and later) paradigms constituted little more than a shuffle away from positivistic and rational planning (Etzioni, 1967; Lindblom, 1959), others marked the start of a significant philosophical refocus towards more social ontologies and non-positivistic epistemologies (Davidoff, 1965; Friedmann, 1993). At the core of this shift was a recognition that planning knowledge, and practice are socially interactive and non-linear in their development (Healey, 2011).

Planners continued to apply more developed computer modelling of complex urban systems, as well as policy frameworks, and general planning principles to inform their 'objective' decision making surrounding spatial planning (Dalton, 1986). While ontologies were diversifying, everyday planning activities changed very little from the rational model in this time frame. Despite the stirrings of the pluralism and increasing emphasis on communication, technologies used in planning remained relatively positivistic and rational in their applications during the 1960s-1980s (e.g. modelling urban growth). By the late 1980s many ICTs that were historically seen as specialist-oriented, such as personal desktop computers and GIS, became more accessible to a broader community of practitioners and stakeholders (Foth, Bajracharya, Brown, & Hearn, 2009).

Desktop computers became an increasingly common sight in the offices of planning practitioners and academics during this period, and by the 1990s were commonly adopted to enhance efficiencies in administration, data management, and facilitate communication (Klosterman, 1997). The Internet and the Web emerged between the late 1970s and 1980s, and became available to the public and businesses in the very late 1980s (Aghaei et al., 2012). By the early to mid 1990s the internet began to proliferate in office environments (including planning departments, agencies and consultancies), enabling planners and other professionals globally to communicate through desktop computers and digitise some of their traditionally analogue or manual tasks (e.g. e-mail, word processing, data management, filing, etc.)(Klosterman, 1997; Klosterman & Landis, 1988). However, as with many technologies, their adoption was socially mediated through workplace priorities, rules, and cultures (te Brömmelstroet, 2010). Notwithstanding evidence of methodological changes as a result of emerging ICTs, and changing understandings of planning practice and theory, there is little evidence to suggest that ICTs significantly shaped planning's underlying epistemologies and ontologies during the above period.

4.3 Communicative Paradigms and ICTs

Based on communicative planning theory Sager (2012) frames planning as 'an open and participatory enterprise involving a broad range of affected groups in socially oriented and fairness-seeking developments of land, infrastructure, or public services'. Communicative planning emerged in the early 1990s and is based on Habermasian communicative rationality and a social constructivist paradigm, which sees the world (and planning) as being created and understood through human interactions and social processes (Healey, 2003). Communicative rationality seeks to develop 'objectivity based on agreement between individuals reached through free and open discourse' (Allmendinger, 2017, p. 243).

Habermas emphasises the role of the public sphere and argues that deliberative and democratic consensus-building can only occur through social interaction in the public sphere (Habermas & Mccarthy, 1991). In practice it has encouraged a shift in the role of planners towards more faciliatory and collaborative roles rather than acting solely as a neutral and expert professional (Healey, 1992). However, this may be an overly positive assessment of planning professionals, who it is unrealistic to assume can be totally neutral, as they likely have their own set of interests influencing their decision-making and actions. Despite the large-scale rejection of instrumental rationality in favour of communicative rationality in the 1960s-present, planning scholars argue that instrumental rationality continues to persist in a complementary, and at times subservient role to communicative paradigms in planning practice and research (Allmendinger, 2017; Huxley & Yiftachel, 2000)

planners have shown that they are slow to adopt some ICTs (Hanzl, 2007; Klosterman, 1997; Vonk, Geertman, & Schot, 2005), they have methodologically embraced Web 2.0 and other ICTs in their day to day approaches in addressing spatial issues (Bugs, Granell, Fonts, Huerta, & Painho, 2010; Foth et al., 2009; Horelli, 2013). Simultaneous to the communicative ontological 'turn', methodologies in planning practice and research became both more participatory, and reliant on ICTs. The web proved particularly important in supporting the ontological and epistemological shift towards understanding planning systems and urban spatial issues as being 'actively constructed in social interaction' (Healey, 2003, p. 115). Web 2.0 enabled stakeholders to not only read about planning issues and policies on local authority websites, but also engage with planning issues in new and more consultative ways (Evans-Cowley & Conroy, 2006). Online participatory platforms and other ICTs tools (e.g. digital citizen forums) were increasingly used to engage with communities on planning, with a large percentage of local planning authorities operating an interactive website, and many also using a formal social media account by the 2010s(Evans-Cowley, 2010; Williamson & Parolin, 2012). GIS also became substantially more participatory from the late 1990s as a result of Web, allowing greater sharing and discussion of spatial data between decision-makers and stakeholders, and community engagement with planning issues (Kleinhans, Van Ham, & Evans-Cowley, 2015; Wu, He, & Gong, 2010). Numerous other 'experimental' (Hanzl, 2007) online planning support systems also emerged in the 2000s further adding to the growing digital toolkit available to planners for public consultation, such as CommunityViz (Kwartler & Bernard, 2001).

While technological developments between the 1960s and 1990s empowered planners to communicate with stakeholders, visualise spatial data, and digitise their administrative tasks (Geertman, 2017; Klosterman, 1992; Lee, 1973), mobile technologies and social media that emerged in the 2000s empowered stakeholders to interact and engage with planners and planning issues more than ever before (Wilson et al., 2017). By the late 2000s many citizens were carrying internet connected and GPS enabled mobile devices (smart phones, and tablets) - devices far smaller and more powerful than the mainframe computers used by planners in the 1960s (Wallin, Saad-Sulonen, Amati, & Horelli, 2012). Mobile devices enable users to simultaneously immerse themselves in real-world environments whilst remaining digitally informed and connected to disparate social networks (Kleinhans et al., 2015). The advent of mobile devices meant that users could increasingly engage with planning issues (perhaps through planning-oriented Facebook pages or Twitter hashtags) at their convenience online, in any location on their mobile devices, rather than limiting themselves to the static location of a desktop, internet connected computer (Evans-Cowley, 2010; Fredericks & Foth, 2013).

Between the early 2000s and late 2000s planners and planning well and truly adopted methodologies supported by ICTs (albeit still unevenly)(Evans-Cowley, 2010; Williamson & Parolin, 2013). Planners had also arguably begun reframing their epistemic understandings of stakeholder engagement and other core planning activities through the prism of ICTs such as social media, online mapping, and interactive local authority websites. ICTs were applied not just as a tool of analysis, but a way of analysing data, connecting people and information, and supporting decision-making in planning systems (Bugs et al., 2010; Foth et al., 2009; Horelli, 2013; Wallin et al., 2012). Ontologically however, the primary focus on communication and communicative rationality during this time was arguably both supported but also in part driven further forward than it otherwise may have been by advances in ICTs and the growing availability of participatory technologies and platforms.

5.0 *Planning 3.0*: A technological turn in planning paradigms?

The concept of ICTs challenging planning paradigms was first raised conceptually by Anttiroiko (2012) in the context of Web 2.0, and later Web 3.0 (Anttiroiko & Caves, 2014). Scholars are increasingly identifying and exploring new ways of approaching planning activities and theories that feature Web 3.0 concepts and increasingly capable ICTs in their framing of urban issues, such as self-organisation (Partanen & Wallin, 2017), and big data (Kitchin, 2014). The literature suggests that these emerging concepts and approaches are arguably indicative of a broader shift or turn in thinking. This shift is referred to in this paper as *Planning 3.0*. *Planning 3.0* is defined as an emerging planning paradigm in which the systems and structures of planning are innately 'smart', drawing on artificial and systemic intelligence to support more responsive and interconnected planning processes.

The emergent nature of the *Planning 3.0* paradigm means that some of its elements (particularly methodological approaches) are already becoming evident in empirical studies in the literature, while many others remain conceptual, and can be interpreted as indicative of prospects and future directions of planning. The sections below explore evidence of ontological, epistemological, and methodological shifts driven or supported by ICTs, and argues that current planning approaches are deviating away from the orientations, and philosophical underpinnings of historical planning paradigms.

5.1 Ontology

While previous ontological approaches in planning have emphasised positivism, deliberative communication, and pluralism, emerging streams of thought in the literature suggest that planning is increasingly defined by complexity, and self-organisation (Partanen & Wallin, 2017; Rantanen & Faehnle, 2017). Cities are highly complex physical, social, economic spaces. They consist of numerous dynamic and interconnected parts, which involve a multitude of exchanges of information, people, energy, and matter (Partanen & Wallin, 2017; Portugali, 1997). This complexity has grown in the last decade as ICTs enable cities to simultaneously consist of constantly changing digital and physical spaces, activities, and interactions(Anttiroiko & Caves, 2014). The consequences of this heightened urban and social complexity are reduced predictability of urban processes, reduced efficacy of traditional planning methodologies in addressing urban issues, and increased periods of chaotic change (Partanen, 2018). Complexity relies on self-organization, which involves components within the system re-organising to produce order, despite a lack of guidance from outside the system (Rantanen & Faehnle, 2017)

In addition to developments in ICTs, citizens in smart cities are consider 'not just a client, user, consumer or recipient of city services, but … a contributor to governance, either directly or indirectly' (Jasmontaite & de Hert, 2019, p. 3). Rantanen and Faehnle (2017, p. 1) argue ICTs are supporting increased social self-organisation, which in turn is driving a 'new phase of urbanisation' in which planning processes and outcomes are increasingly 'user-driven' and decentralised. Wallin, Horelli, and Saad-Sulonen (2010) argue that ICTs are now facilitating co-learning, and broadening the reach of planners' engagement activities, and enable those who 'do not live in the place but feel connected to it, or other active groups who wish to be involved in the planning' (Horelli, 2013, p. 142). A review of three Finnish case studies by Saad-Sulonen (2014) also found that planners and communities are increasingly interacting beyond traditional communicative Web 2.0 ICTs such as emails, and online consultation forms, and the gap between citizens and planners is narrowing thanks to new Web 3.0 based ICTs. In the case of the Hertonniemi neighbourhood in Helsinki, stakeholders used community informatics gathered from traditional consultation events, as well as a host of Web 3.0 tools (e.g. Urban mediator – an online tool enabling individuals to collect, create, and share location based information) to develop a community park and community centre (Partanen & Wallin, 2017). In this case study, the local community acted in the role of planner, rather than engaging with government planner, formal development strategies, or planning processes(Partanen & Wallin, 2017). These case studies are also reflected in the 'material turn' in planning which emphasises assemblage thinking, and the role of networks in delivering planning outcomes (Rydin, 2014).

There is a growing body of literature that argues that the emergence of self-organisation in planning systems is signalling a shift towards a more 'co-operative' planning ontology of the 'algorithmic age' (Ertiö & Bhagwatwar, 2017; Rantanen & Faehnle, 2017). The ultimate impact of this is the decentralisation the planning system, in which planners are no longer 'professionals at the centre of the societal universe, pulling the levers of control' (Allmendinger, 2017, p. 146). Arguably Planning 3.0 represents a bigger social shift than technological because it is in essence about self-organisation. Planning 3.0 moves towards citizens taking on the role of planners, and communities using ICT-facilitating crowdsourcing of data and citizen proposals to personalise of planning processes and plans to better reflect their unique set of needs, characteristics, and identities. Community informatics combined with semantic and intelligent algorithms could enable smarter planning. That is to say planning processes could use ICTs not just to quantify cities, but also be more conscious of the dynamic meanings and feelings of individual experiences of those cities to develop more responsive and adaptive urban environments and planning processes that reflect the residents they serve (Palti & Bar, 2015).

5.2 Epistemology

The literature argues that epistemologically planning is becoming 'smarter', and knowledge within planning systems becoming more available, democratic and interconnected as a result of the inclusion of new ways gathering, analysing, interpreting, and visualising data (Anttiroiko & Caves, 2014; Laurini, 2017) . There are however signs of epistemological contradiction in the literature regarding the integration of ICTs into planning processes and thinking. Much of the smart city literature espouses tools reliant on realist epistemologies (Kitchin, Lauriault, & McArdle, 2015; Kummitha & Crutzen, 2017). On the other hand, much of the discussion of the digitisation of planning processes and the changing relationship between individuals, planning structures, and planning processes represent a more constructivist and relational approach (Horelli, Saad-Sulonen, Wallin, & Botero, 2015; Saad-Sulonen, 2014).

Smart city scholars argue that ICTs can improve the efficiency and efficacy of planning and urban functionality through monitoring, tracking and modelling of urban systems (Papadopoulou & Panagiotopoulou, 2015; Rathore, Ahmad, Paul, & Rho, 2016; Yigitcanlar et al., 2018). In this context knowledge is considered explicit and apolitical, and cities are seen as measurable and thus able to be visualised accurately through the culmination of objective, and value neutral data (Kitchin et al., 2015). A host of algorithms, heuristics, artificial intelligence are used to process and make sense of this data (Kreps & Kimppa, 2015). While these Web 3.0 tools are yet to be embedded in everyday planning practice, conceptually they offer planners the ability to integrate multiple streams of data, and generate task or question specific information (Anttiroiko & Caves, 2014).

Web 3.0 informatics go beyond interactive tools introduced by Web 2.0, and offer the ability to identify and extrapolate meaning from the connectivity between numerous and often real-time data sets (Kreps & Kimppa, 2015). The rate of data creation and distribution continues to grow rapidly, leading to data sets that an individual planner can no longer conceivably absorb and draw meaning from in a reasonable time frame (Kitchin et al., 2015). Rather, machine learning and semantic intelligence are increasingly capable of filtering, integrating, and creating potentially more meaningful content than capable through Web 2.0 tools (Laurini, 2017). This means knowledge in planning systems (and arguably society more broadly) is developed by both individuals and ICTs. Semantic intelligence enables the formation of connections between the plethora concepts that are presented to us through our physical and digital experiences (Kitchin et al., 2015). Ultimately, there is no suggestion in the literature that planning will become automated, particularly due to the subjectivity and value judgements involved in much of planning practice. The growth of semantic and artificial intelligence, however, offers planners new opportunities for developing novel solutions in complex urban environments by considering the interconnectivity of numerous elements within such systems.

The emergence of self-organisation ontologies in planning systems is also stimulating an extension of constructivist epistemologies with a greater emphasis on collaborative co-development and management of knowledge. Barassi and Treré (2012) argue that Web 3.0 tools trigger citizen cooperation (as opposed to participation in Web 2.0) by networking users and embedding them in knowledge creation and management processes. The subjective knowledge created by individuals, and shared on social media (Web 2.0), is increasingly integrated with other users' data to generate new meanings (Kreps & Kimppa, 2015; Scardamalia & Bereiter, 2014). For example, in 2009 a UK-based coder sought to crowdsource data from users regarding the extent of a snow event in their postcode on Twitter (Kreps & Kimppa, 2015). This information was gathered and then combined with Google maps data to develop a 'Twitter stream' that generated a real-time snow-map of the UK (Kreps & Kimppa, 2015). Knowledge in Planning 3.0 could subsequently be seen as an amalgam of individual's experiences, and something that users can actively contribute to in the form of a real-time, constantly emerging and evolving stream of knowledge. This approach emphasises the subjective, dynamic and contextual nature of knowledge, and encourages citizens to actively contest knowledge as it is created (Scardamalia & Bereiter, 2014; Tambakaki, 2014). In a planning context, this shift can be seen in the difference between Web 2.0 tools such as social media where planners ask communities for their suggestions or perspectives on a project, and Web 3.0 decentralisation in which communities rely on amalgamating different ICTs and their capabilities to enable self-organisation, problem-solving and action on urban issues (Saad-Sulonen, 2014).

Notwithstanding the opportunities raised above, positivistic approaches remain problematic. Positivistic planning approaches tend to reduce cities into measurable components, rather than recognising the messy complexity, history, and interrelationships of those components (Söderström, Paasche, & Klauser, 2014). Moreover, algorithms, machine learning, and artificial intelligence as outputs of human programming are inherently value-laden, and thus depending on their programming can perpetuate existing urban inequalities, or be manipulated by private interests and the values of those involved in programming them (likely not urban planners)(Stratigea et al., 2015). Epistemologically, simply using ICTs to measure and model cities in new ways does not represent a step forward, but rather a step backward toward the rational planning paradigm. The enhanced connectivity of data streams combined with the increasing democratisation of planning processes introduced by Web 2.0 tools, however, represents an increasingly relational epistemology emphasising the connections between a plurality of data points, perspectives, and networks of individuals.

5.3 Methodology

Many of the traditional methodologies and instruments of enacting planning decision-making have been translated into digital formats in recent decades (Klosterman, 2013). However, such digitisations have largely not revolutionised planning practice, and arguably have perpetuated traditional methodologies on new devices (particularly in the context of public participation) and is unlikely to overcome the many cited obstacles to meaningful public engagement (Evans-Cowley & Hollander, 2010). Aside from this however, there are a number of emerging methodologies supported by the Web 3.0 ontologies and epistemologies discussed above, that represent a significant step forwards methodologically for planning practice. Virtual and augmented reality (ARUP, 2017), city dashboards (Kitchin et al., 2015), and dynamic planning instruments (Terrain NRM, 2020) are gaining traction in practice. These tools are still emerging in planning practice, but are all centred around building the capacity of planning systems to engage in dynamic and 'real-time planning' (Zeile, 2017).

Augmented and virtual reality are increasingly used in planning practice to not only transform traditional two-dimensional renderings of proposed projects into three-dimensional visualisations, but also co-designing urban interventions in-situ, and visualising or visualising development proposals contextually in physical spaces (ARUP, 2017; Lock, Bednarz, & Pettit, 2019; Zeile, 2017). The primary applications of augmented and virtual reality in planning practice to date have largely been linked to visualising proposals for public participation (Jutraz & Zupancic, 2015). Visualisation ICTs are increasingly capable of integrating with large and complex data sets stemming from urban environments (Aukstakalnis, 2016), extending augmented and virtual reality beyond a methodology for participation and engagement, to a potential format for analytics, scenario testing, and interactive decision-support systems.

Contemporary urban environments involve the generation of countless, and generally very big public and private data sets on urban functions and citizen activities, and multitudes of algorithms interpreting and aggregating that data, often in real-time (Kitchin, 2014). In a data-rich urban context, traditional approaches and planning instruments, such as the comprehensive plan and zoning codes, are arguably no longer fit for purpose because they are unable to respond to the volume, velocity and relational nature of the data being produced (i.e. big data). A number of radical methodologies are currently emerging in practice to address this issue include algorithmic approaches to zoning that rely on machine learning to maximise citizen outcomes of urban development (Brauneis & Goodman, 2018; Crichton, 2018; Hamilton, Karahalios, Sandvig, & Langbort, 2014), 'live' website based plans that are regularly updated as new data is made available (Terrain NRM, 2020), and one-stop city dashboards or data analytic hubs drawing together real-time data from across city departments enabling planners use machine learning to develop 'smarter' planning solutions (Kitchin, 2014). These novel examples also represent significant breaks with traditional planning ontologies in their emphasis on the complexity of planning systems, and the use of systemic intelligence to better link real-time and location-specific data with planning processes. They suggest ICTs are enabling a shift towards more responsive and dynamic *Planning 3.0* structures capable of reading, comprehending, connecting, and applying information to support the delivery of specific planning outcomes in real-time.

Emerging ICTs represent not only a growing methodological opportunity for planners, but also a significant risk to planners, planning systems, and stakeholders more broadly. The emphasis on real-time data collection is based on the ongoing surveillance of urban functions and citizens and subsequently raises concerns regarding individuals' privacy, and the security and ownership of data (Kitchin & Dodge, 2019). Furthermore, there is a risk that with greater reliance on ICTs developed by private organisations comes an increasing marketisation and privatisation of city functions (Hollands, 2008), path dependency on specific ICTs systems or corporations (Bates, 2012), and the reduction of cities into widgets that fail to acknowledge the diversity and uniqueness of different localities, cities, and regions (Kitchin et al., 2015).

6.0 Conclusions

The broader context in which urban planning occurs has changed substantially in recent decades. Digitalization has driven major social, economic, and physical changes in cities, leading to higher levels of complexity and higher levels of dynamism and interconnectivity between people, energy, spaces, and ideas(Partanen & Wallin, 2017; Portugali, 1997). Citizens are more connected to each other and capable of accessing information instantaneously whilst going about their daily lives through mobile devices (Jasmontaite & de Hert, 2019). ICTs such as artificial intelligence, machine learning, augmented/virtual reality, and location-based services increasingly being used to support citizens and planners in decision-making (Kitchin, 2014; Kitchin et al., 2015). The rapid growth of literature focussed on concepts such as smart cities is further evidence that new ways of thinking about urban planning and cities generally are emerging in response to ICTs (Brauneis & Goodman, 2018; Tang, Hou, Fay, & Annis, 2019; Wilson et al., 2017). While not all planning activities rely on Web 3.0 based ICTs, their progressive evolution and presence in planning systems appears to have catalysed changes to the fundamental assumptions of planning as a discipline. As a whole they are evidence of a progressive paradigm shift towards Planning 3.0.

The emergent *Planning 3.0* paradigm is evidenced by a shifting understanding of cities as the focus of planning, new methodologies, and knowledge systems that combine, analyse and interpret multiple streams of data in real-time. Case studies in Finland emphasise growing trends towards decentralisation, self-organisation, and integration of relational, local informatics as a response to increased complexity and citizens' desires for a more responsive planning system. While the burgeoning smart cities literature, and introduction of city dashboards and other ICTs into city infrastructures suggests an increasing move towards cities using real-time data and intelligent software to support the analysis and interpretation of urban dynamics. As evidence supporting the arguments surrounding *Planning 3.0* are still emerging, there is a need for greater research exploring the implications of this paradigm shift in different planning contexts, and the capacity of planners to use different types of ICTs. Further research is also needed to ground truth the actual use of ICTs in planning practice, and the relationship between planners, ICTs and the core tasks in planning systems

Just as the transitions from Web 1.0 to Web 3.0 were not linear, the evolution of planning paradigms in the last decade has been far from linear. *Planning 3.0* is not a general theory of planning. Rather, *Planning 3.0* represents a cultural shift that recognises that urban systems underpinning planning are changing, and the core ontologies, epistemologies and methodologies of planning are shifting in response. Elements of previous planning paradigms will likely persist for many years to come; however, it is clear contemporary approaches to planning are increasingly distinct and strongly tied to the emergence and evolution of ICTs.

7.0 References

Aghaei, S., Nematbakhsh, M. A., & Farsani, H. K. (2012). Evolution of the world wide web: From WEB 1.0 TO WEB 4.0. *International Journal of Web & Semantic Technology, 3*(1), 1.

Allmendinger, P. (2017). *Planning theory*. Cambridge: Macmillan International Higher Education.

Allmendinger, P., & Tewdwr-Jones, M. (2002). The communicative turn in urban planning: Unravelling paradigmatic, imperialistic and moralistic dimensions. *Space and polity, 6*(1), 5-24.

Antezana, E., Kuiper, M., & Mironov, V. (2009). Biological knowledge management: the emerging role of the Semantic Web technologies. *Briefings in bioinformatics, 10*(4), 392-407.

Anttiroiko, A.-V. (2012). Urban Planning 2.0. *International Journal of E-Planning Research (IJEPR), 1*(1), 16-30.

Anttiroiko, A.-V., & Caves, R. W. (2014). Urban Planning 3.0: Impact of recent developments of the Web on urban planning. In *IT in the Public Sphere: Applications in Administration, Government, Politics, and Planning* (pp. 233-257): IGI Global.

Arthur, W. B. (2009). *The nature of technology: What it is and how it evolves*. New York: Simon and Schuster.

ARUP. (2017). Virtual and Augmented reality changing the way we design and build infrastructure. Retrieved from https://www.arup.com/perspectives/virtual-and-augmented-reality-changing-the-way-we-design-and-build-infrastructure

Ash, J., Kitchin, R., & Leszczynski, A. (2018). Digital turn, digital geographies? *Progress in Human Geography, 42*(1), 25-43.

Aukstakalnis, S. (2016). *Practical augmented reality: A guide to the technologies, applications, and human factors for AR and VR*: Addison-Wesley Professional.

Barassi, V., & Treré, E. (2012). Does Web 3.0 come after Web 2.0? Deconstructing theoretical assumptions through practice. *New Media & Society, 14*(8), 1269-1285.

Bates, J. (2012). This is what modern deregulation looks like": co-optation and contestation in the shaping of the UK's Open Government Data Initiative. *The Journal of Community Informatics, 8*(2), 1-20.

Berners-Lee, T. (2010). Long live the web. *Scientific American, 303*(6), 80-85.

Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The semantic web. *Scientific American, 284*(5), 28-37.

Brauneis, R., & Goodman, E. P. (2018). Algorithmic transparency for the smart city. *Yale JL & Tech., 20*, 103.

Bugs, G., Granell, C., Fonts, O., Huerta, J., & Painho, M. (2010). An assessment of Public Participation GIS and Web 2.0 technologies in urban planning practice in Canela, Brazil. *Cities, 27*(3), 172-181.

Choudhury, N. (2014). World wide web and its journey from web 1.0 to web 4.0. *International Journal of Computer Science and Information Technologies, 5*(6), 8096-8100.

Crichton, D. (2018). Algorithmic Zoning could be the answer to cheaper housing and more equitable cities. Retrieved from https://techcrunch.com/2018/02/19/algorithmic-zoning-could-be-the-answer-to-cheaper-housing-and-more-equitable-cities/

Dalton, L. C. (1986). Why the Rational Paradigm Persists — The Resistance of Professional Education and Practice to Alternative Forms of Planning. *Journal of Planning education and research, 5*(3), 147-153. doi:10.1177/0739456X8600500302

Davidoff, P. (1965). Advocacy and pluralism in planning. *Journal of the American Institute of Planners, 31*(4), 331-338.

Davoudi, S., & Pendlebury, J. (2010). Centenary paper: The evolution of planning as an academic discipline. *Town planning review, 81*(6), 613-646.

de Satgé, R., & Watson, V. (2018). *Conflicting Rationalities and Southern Planning Theory*. online e-book: Springer.

Eckberg, D. L., & Hill Jr, L. (1979). The paradigm concept and sociology: A critical review. *American Sociological Review*, 925-937.

Ertiö, T.-P., & Bhagwatwar, A. (2017). Citizens as planners: Harnessing information and values from the bottom-up. *International Journal of Information Management, 37*(3), 111-113.

Etzioni, A. (1967). Mixed-scanning: A" third" approach to decision-making. *Public administration review*, 385-392.

Evans-Cowley, J. S. (2010). Planning in the age of Facebook: the role of social networking in planning processes. *GeoJournal, 75*(5), 407-420.

Evans-Cowley, J. S., & Conroy, M. (2006). The growth of e-government in municipal planning. *Journal of Urban Technology, 13*(1), 81-107. doi:10.1080/10630730600752892

Evans-Cowley, J. S., & Hollander, J. (2010). The new generation of public participation: Internet-based participation tools. *Planning Practice & Research, 25*(3), 397-408.

Faludi, A. (2013). *A reader in planning theory* (Vol. 5). Oxford: Elsevier.

Forester, J. (1988). *Planning in the Face of Power*. Los Angeles: Univ of California Press.

Foth, M., Bajracharya, B., Brown, R., & Hearn, G. (2009). The Second Life of urban planning? Using NeoGeography tools for community engagement. *Journal of Location Based Services, 3*(2), 97-117.

Fredericks, J., & Foth, M. (2013). Augmenting public participation: enhancing planning outcomes through the use of social media and web 2.0. *Australian planner, 50*(3), 244-256.

Friedmann, J. (1993). Toward a non-Euclidian mode of planning. *Journal of the American Planning Association, 59*(4), 482-485.

Fuchs, C., Hofkirchner, W., Schafranek, M., Raffl, C., Sandoval, M., & Bichler, R. (2010). Theoretical foundations of the web: cognition, communication, and co-operation. Towards an understanding of Web 1.0, 2.0, 3.0. *Future Internet, 2*(1), 41-59.

Garrigos-Simon, F. J., Lapiedra Alcami, R., & Barbera Ribera, T. (2012). Social networks and Web 3.0: their impact on the management and marketing of organizations. *Management Decision, 50*(10), 1880-1890.

Geertman, S. (2017). PSS: Beyond the implementation gap. *Transportation Research Part A: Policy and Practice, 104*, 70-76.

Gordon, E., Schirra, S., & Hollander, J. (2011). Immersive planning: a conceptual model for designing public participation with new technologies. *Environment and Planning B: Planning and Design, 38*(3), 505-519.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194), 105.

Habermas, J., & Mccarthy, T. (1991). *The structural transformation of the public sphere: An inquiry into a category of bourgeois society*. Cambridge: MIT press.

Hajer, M. A., Hoppe, R., & Jennings, B. (1993). *The argumentative turn in policy analysis and planning*. London: Duke University Press.

Hamilton, K., Karahalios, K., Sandvig, C., & Langbort, C. (2014). The image of the algorithmic city: a research approach. *IxD&A, 20*, 61-71.

Hanzl, M. (2007). Information technology as a tool for public participation in urban planning: a review of experiments and potentials. *Design Studies, 28*(3), 289-307.

Harris, N. (2005). Collaborative Planning: From Theoretical Foundations to Practice Forms. In P. Allmendinger & M. Tewdwr-Jones (Eds.), *Planning futures: new directions for planning theory* (pp. 21-43): Routledge.

Healey, P. (1992). Planning through debate: the communicative turn in planning theory. *Town planning review, 63*(2), 143.

Healey, P. (1996). The communicative turn in planning theory and its implications for spatial strategy formation. *Environment and Planning B: Planning and Design, 23*(2), 217-234.

Healey, P. (2003). Collaborative Planning in Perspective. *Planning Theory, 2*(2), 101-123. doi:10.1177/14730952030022002

Healey, P. (2011). Foreword. In J. Friedmann (Ed.), *Insurgencies: Essays in planning theory*. Abingdon, Oxon: Routledge.

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City, 12*(3), 303-320.

Horelli, L. (2013). Participatory e-planning meets the glocal. *New Approaches to Urban Planning: Insights from Participatory Communities*, 131-152.

Horelli, L., Saad-Sulonen, J., Wallin, S., & Botero, A. (2015). When self-organization intersects with urban Planning: Two cases from Helsinki. *Planning Practice & Research, 30*(3), 286-302.

Huxley, M., & Yiftachel, O. (2000). New paradigm or old myopia? Unsettling the communicative turn in planning theory. *Journal of Planning education and research, 19*(4), 333-342.

Innes, J. E. (1995). Planning Theory's Emerging Paradigm: Communicative Action and Interactive Practice. *Journal of Planning education and research, 14*(3), 183-189. doi:10.1177/0739456X9501400307

Jasmontaite, L., & de Hert, P. (2019). Access to the Internet in the EU: a policy priority, a fundamental, a human right or a concern for eGovernment? In *Research Handbook on Human Rights and Digital Technology*: Edward Elgar Publishing.

Jutraz, A., & Zupancic, T. (2015). Virtual worlds as support tools for public engagement in urban design. In *Planning Support Systems and Smart Cities* (pp. 391-408): Springer.

Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal, 79*(1), 1-14.

Kitchin, R., & Dodge, M. (2019). The (in) security of smart cities: Vulnerabilities, risks, mitigation, and prevention. *Journal of Urban Technology, 26*(2), 47-65.

Kitchin, R., Lauriault, T. P., & McArdle, G. (2015). Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science, 2*(1), 6-28. doi:10.1080/21681376.2014.983149

Kleinhans, R., Van Ham, M., & Evans-Cowley, J. (2015). Using social media and mobile technologies to foster engagement and self-organization in participatory urban planning and neighbourhood governance. In: Taylor & Francis.

Klosterman, R. (1992). Evolving Views of Computer-Aided Planning. *Journal of Planning Literature, 6*(3), 249-260. doi:10.1177/088541229200600303

Klosterman, R. (1997). Planning support systems: a new perspective on computer-aided planning. *Journal of Planning education and research, 17*(1), 45-54.

Klosterman, R. (2013). Lessons learned about planning: forecasting, participation, and technology. *Journal of the American Planning Association, 79*(2), 161-169.

Klosterman, R., & Landis, J. D. (1988). Microcomputers in US Planning: Past Present and Future. *Environment and Planning B: Planning and Design, 15*(3), 355-367. doi:10.1068/b150355

Kreps, D., & Kimppa, K. (2015). Theorising Web 3.0: ICTs in a changing society. *Information Technology & People, 28*(4), 726-741.

Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Kummitha, R. K. R., & Crutzen, N. (2017). How do we understand smart cities? An evolutionary perspective. *Cities, 67*, 43-52.

Kwartler, M., & Bernard, R. N. (2001). CommunityViz: an integrated planning support system. *Planning support systems: Integrating geographic information systems, models and visualization tools*, 285-308.

Laurini, R. (2017). Towards smart urban planning through knowledge infrastructure. *diamond*, 75-80.

Lee, D. (1973). Requiem for large-scale models. *Journal of the American Institute of Planners, 39*(3), 163-178.

Lindblom, C. E. (1959). The science of muddling through. *Public administration review, 19*(2), 79-88.

Lock, O., Bednarz, T., & Pettit, C. (2019). *HoloCity–exploring the use of augmented reality cityscapes for collaborative understanding of high-volume urban sensor data.* Paper presented at the The 17th International Conference on Virtual-Reality Continuum and its Applications in Industry.

McLoughlin, J. B. (1969). *Urban & regional planning: a systems approach*: Faber and Faber.

Newman, R., Chang, V., Walters, R. J., & Wills, G. B. (2016). Web 2.0—The past and the future. *International Journal of Information Management, 36*(4), 591-598.

O'Reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & strategies*(1), 17.

Palti, I., & Bar, M. (2015). A manifesto for conscious cities: should streets be sensitive to our mental needs? *The Guardian*. Retrieved from https://www.theguardian.com/cities/2015/aug/28/manifesto-conscious-cities-streets-sensitive-mental-needs

Papadopoulou, C.-A., & Panagiotopoulou, M. (2015). Tools and Technologies for Planning the Development of Smart Cities. *Journal of Urban Technology, 22*(2), 43-62. doi:10.1080/10630732.2015.1018725

Partanen, J. (2018). *'Don't Fix It if It Ain't Broke': Encounters with Planning for Complex Self-Organizing Cities.* (Doctor of Science in Technology), Tampere University of Technology, Tampere, Finland.

Partanen, J., & Wallin, S. (2017). Bridging soft and hard–Towards a more coherent understanding of self-organisation within urban complexity research. *Finnish Journal of Urban Studies, Online*.

Portugali, J. (1997). Self-organizing cities. *Futures, 29*(4-5), 353-380.

Prabhu, D. (2017). *Application of web 2.0 and web 3.0: an overview*: LAP LAMBERT Academic Publishing.

Price, S., Jewitt, C., & Brown, B. (2013). *The Sage handbook of digital technology research*: Sage.

Rantanen, A., & Faehnle, M. (2017). Self-organisation challenging institutional planning: Towards a new urban research and planning paradigm—A Finnish review. *Urban Studies, 3*, 55.

Rathore, M. M., Ahmad, A., Paul, A., & Rho, S. (2016). Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks, 101*, 63-80.

Roy, A. (2009). Strangely familiar: Planning and the worlds of insurgence and informality. *Planning Theory, 8*(1), 7-11.

Rydin, Y. (2014). The challenges of the "material turn" for planning studies. *Planning Theory & Practice, 15*(4), 590-595.

Saad-Sulonen, J. (2014). *COMBINING PARTICIPATIONS. Expanding the Locus of Participatory E-Planning by Combining Participatory Approaches in the Design of Digital Technology and in Urban Planning*: Aalto University.

Sager, T. Ø. (2012). *Reviving critical planning theory: Dealing with pressure, neo-liberalism, and responsibility in communicative planning*: Routledge.

Sandercock, L. (2010). From the campfire to the computer: An epistemology of multiplicity and the story turn in planning. In *Multimedia explorations in urban policy and planning* (pp. 17-37): Springer.

Scardamalia, M., & Bereiter, C. (2014). Smart technology for self-organizing processes. *Smart Learning Environments, 1*(1), 1.

Scott, A. J., & Roweis, S. T. (1977). Urban planning in theory and practice: a reappraisal. *Environment and planning A, 9*(10), 1097-1119.

Selwyn, N. (2004). Reconsidering political and popular understandings of the digital divide. *New Media & Society, 6*(3), 341-362.

Servon, L. J., & Nelson, M. K. (2001). Community technology centers: narrowing the digital divide in low-income, urban communities. *Journal of Urban Affairs, 23*(3-4), 279-290.

Sheller, M., & Urry, J. (2006). The new mobilities paradigm. *Environment and planning A, 38*(2), 207-226.

Shepherd, C., & Challenger, R. (2013). Revisiting paradigm (s) in management research: A rhetorical analysis of the paradigm wars. *International Journal of Management Reviews, 15*(2), 225-244.

Silva, C. N. (2010). The e-planning paradigm–Theory, methods and tools: An overview. In *Handbook of research on e-planning: ICTs for urban development and monitoring* (pp. 1-14): IGI Global.

Söderström, O., Paasche, T., & Klauser, F. (2014). Smart cities as corporate storytelling. *City, 18*(3), 307-320.

Stratigea, A., Papadopoulou, C.-A., & Panagiotopoulou, M. (2015). Tools and technologies for planning the development of smart cities. *Journal of Urban Technology, 22*(2), 43-62.

Tambakaki, P. (2014). The Tasks of Agonism and Agonism to the Task: Introducing 'Chantal Mouffe: Agonism and the Politics of Passion'. *Parallax, 20*(2), 1-13. doi:10.1080/13534645.2014.896543

Tang, T., Hou, J., Fay, D. L., & Annis, C. (2019). Revisit the drivers and barriers to e-governance in the mobile age: A case study on the adoption of city management mobile apps for smart urban governance. *Journal of Urban Affairs*, 1-23. doi:10.1080/07352166.2019.1572455

te Brömmelstroet, M. (2010). Equip the warrior instead of manning the equipment: Land use and transport planning support in the Netherlands. *Journal of transport and land use, 3*(1), 25-41.

Terrain NRM. (2020). *Wet Tropics Plan for People and Country*. Retrieved from Cairns, Australia: https://www.wettropicsplan.org.au/about-the-plan/planning-process/

Vonk, G., Geertman, S., & Schot, P. (2005). Bottlenecks blocking widespread usage of planning support systems. *Environment and planning A, 37*(5), 909-924.

Wallin, S., Horelli, L., & Saad-Sulonen, J. (2010). Digital tools in participatory planning.

Wallin, S., Saad-Sulonen, J., Amati, M., & Horelli, L. (2012). Exploring e-planning practices in different contexts: Similarities and differences between Helsinki and Sydney. *International Journal of E-Planning Research (IJEPR), 1*(3), 17-39.

Watson, V. (2016). Shifting approaches to planning theory: global north and south. *Urban Planning, 1*(4), 32-41.

Whited, W. L. (1982). *Using Microcomputers in Urban Planning*. Retrieved from Chicago, IL:

Wildavsky, A. (1973). If planning is everything, maybe it's nothing. *Policy sciences, 4*(2), 127-153.

Williamson, W., & Parolin, B. (2012). Review of Web-Based Communications for Town Planning in Local Government. *Journal of Urban Technology, 19*(1), 43-63. doi:10.1080/10630732.2012.626702

Williamson, W., & Parolin, B. (2013). Web 2.0 and social media growth in planning practice: A longitudinal study. *Planning Practice and Research, 28*(5), 544-562.

Wilson, A., Tewdwr-Jones, M., & Comber, R. (2017). Urban planning, public participation and digital technology: App development as a method of generating citizen involvement in local planning processes. *Environment and Planning B: Urban Analytics and City Science*, 2399808317712515. doi:10.1177/2399808317712515

Wu, H., He, Z., & Gong, J. (2010). A virtual globe-based 3D visualization and interactive framework for public participation in urban planning processes. *Computers, Environment and Urban Systems, 34*(4), 291-298.

Yigitcanlar, T., Kamruzzaman, M., Buys, L., Ioppolo, G., Sabatini-Marques, J., da Costa, E. M., & Yun, J. J. (2018). Understanding ‘smart cities’: Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities, 81*, 145-160.

Zeile, P. (2017). *Urban emotions and realtime planning methods.* Paper presented at the REAL CORP 2017–PANTA RHEI–A World in Constant Motion. Proceedings of 22nd International Conference on Urban Planning, Regional Development and Information Society.