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Professional planners' preparedness for digital transformation: an empirical analysis of PlanTech

COVID-19 lockdowns led to significant shifts in how professional planners operate. The introduction of advanced digital technologies enabled home working and virtual planning processes. An important line of academic inquiry concerns planners' preparedness in adopting and adapting to digital transformation. Focusing on Northern Ireland, we offer a nuanced analysis of planners' experiences of digital technologies by drilling into the demographics and competencies within the different planning sectors to disaggregate different types of planners by age, gender, seniority and skills. We present a fine-grained analytical canvas to reveal how different types of planners are experiencing the next stages of digital transformation.

Keywords: planners, preparedness, technology, skills, gap

Introduction

COVID-19 stimulated new research agendas in urban and regional planning (Lennon, 2023). One area concerns the role of advanced information and communication technologies (ICTs) in planning processes. Indeed, recent issues of this journal discussed the impact of digital technology on the planning system and how professional planners perform their roles (Goode, 2021; Milz and Gervich, 2021; Ormerod and Davoudi, 2021; Wilson and Tewdwr-Jones, 2022). As these articles argued, planners have used various technologies in their everyday work environment for decades. However, coordinating planning processes during and after the pandemic led to deeper discussions on the current and future role of digital technologies (Boland et al., 2022). One prominent area of academic attention that has emerged post-COVID-19 relates to planners' preparedness for the 'digital revolution' (Wilson and Tewdwr-Jones, 2022). On this, recent writings from different parts of the world ruminate on the ability of planners to adopt digital technologies (Daniel et al., 2024; Einstein et al., 2023; Goode, 2021; Gower et al., 2023; Hafferty et al., 2024; Johnson et al., 2020; Kitchin et al., 2021; Megahed

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and Abdel-Kader, 2022; Milz and Gervich, 2021; Mualam et al., 2022; Potts and Webb, 2023). In this journal, Wilson and Tewdwr-Jones (2022, 502) claim, 'there is little understanding of the widespread use of technology across the planning system'. They also argue the pandemic increased digital technology adoption in the UK; however, the adaptability of planners is a concern. Likewise, a US study suggests future scholarship should address planners' 'readiness and training' to uptake digital technologies (Meenar and Afzalan, 2023). Reinforcing the point, a multi-country study shows 'variation in perceived preparedness' amongst groups of planners (Daniel et al., 2024). Given this, we respond to Gower et al's (2023, 666) 'call for more research on how planners understand [and use] digital tools'.

This article contributes to broader discussions in this journal, and elsewhere, concerning planning and technology. It uses an analysis of planning professionals' experiences of adapting to advanced digital technologies to explain the various ways planning work is being transformed. We drill into the demographics and competencies within different planning sectors to disaggregate different types of planners by age, gender, seniority and skills. In this way, we create a fine-grained analytical canvas to reveal how different types of planners are experiencing digital transformation. Thus, we expose the variability amongst different types of professionals working within and between planning sectors. Such findings are timely given that the 'planning profession itself has grown slowly to adjust to the new opportunities initiated by technological change' (Batty and Yang, 2022, 7). To ground the study, the spatial spotlight shines on Northern Ireland, an interesting research laboratory given that it is, at one and the same time, jurisdictionally part of the United Kingdom and economically and geographically an integral part of the island of Ireland, a dual reality that is captured in the fallout from Brexit (Keating, 2022). We note that recent studies analyse digital technology use amongst planning professionals in England (Wilson and Tewdwr-Jones, 2022) and the Republic of Ireland (Kitchin et al., 2021), whereas Northern Ireland is unexplored. Finally, reflecting upon the article's contribution to knowledge, we conclude with a discussion of the broader implications of the 'digital revolution' for contemporary urban planning.

Digital technology and planning professionals

Technology has been a driving force for economic and societal change, captured in three industrial revolutions from steam and waterpower to technology and electrification and, more recently, computerisation and the internet. At the turn of the twenty-first century, innovation and technology played a pivotal role in delivering the 'economic nirvana' of city competitiveness (Begg, 1999). Most recently, the 'digital turn' (Ash et al., 2018) and fourth industrial revolution (James et al., 2020) – 'digital by default' (Batty and Yang, 2022) – transformed how cities function. For example,

how we use urban data through hand-held and wearable ('always on') technologies (Evans-Cowley, 2010; Johnson et al., 2020)[1] that enable people to interact with each other, organise their work and social lives, and navigate cityspaces. Innovations such as the Internet of Things (IoT), big data, cloud computing, artificial intelligence (AI) and machine learning (ML) created an intimately interconnected world. These changes are captured in the smart city literature (James et al., 2020; Kitchin, 2014; Levenda et al., 2020; Luque-Ayala and Marvin, 2015; Megahed and Abdel-Kader, 2022; Pan et al., 2022). This literature argues that smart cities use advanced technologies to collect datasets and manage assets, resources and services more efficiently.[2] Moreover, smarter planning (Moraci et al., 2018) might 'promote equitable development, sustainable growth, and quality of life' (Meenar and Afzalan, 2023, 23). Other popular conceptualisations include urban informatics (Unsworth et al., 2014), platform urbanism (Barns, 2019), computational urbanism (Safransky, 2020), cyborg urbanism (Wiig and Wyly, 2016), city dashboards (Young et al., 2021) and algorithmic governance (Kitchin, 2017).

In the US, decisions on access to local services and amenities use algorithms that profile people and place based on demographic and economic factors and personal habits. Safransky (2020, 215) questions, 'how seemingly neutral technologies can be embedded with social values, assumptions, and biases', warning of 'algorithmic violence'. Others argue algorithms, AI/ ML, and other forms of human programmed software and hardware retain the conscious and unconscious biases of those who design them (Sun et al., 2020; Turner Lee, 2018). Therefore, while the benefits of shifting towards virtual planning processes and decision-making are widely acknowledged, there remain 'potential dangers'[3] (Boland et al., 2022; Einstein et al., 2023; Milz and Gervich, 2021; Ormerod and Davoudi, 2021). On this, Robinson and Johnson (2021, 62) warn, '[c]ivic technologies, which are intended to deliver public good outcomes in their design including those being proposed to respond to COVID-19, are vulnerable to the same limitations as for-profit technology tools'. Thus, digital technology use in planning processes simultaneously represents an opportunity and a threat to inclusivity, transparency and the public interest.

Planning and technology: PlanTech

The increasing presence of digital technology in various parts of the planning process and its uptake amongst private and public sector professionals has spawned new concepts in PropTech (Porter et al., 2019) and PlanTech (Devlin, 2020). As the name

1 Digital devices, Government 2.0, open data, citizen applications and Web 2.0 paradigm of web-based interfaces.

2 It must be noted that the smart city is a 'contested term … with dozens of definitions and visions of the city' (Johnson et al., 2020, 1; for further criticism see Meenar and Afzalan, 2023).

3 Most evidently, these include digital divides, democratic deficits and hidden algorithms.

suggests, PropTech refers to the use of digital technologies in the property sector; PlanTech, however, is a broader concept as it captures the use of digital technologies to 'create better places'. In this sense, and connecting to the above discussion, PlanTech will, arguably, 'revolutionise the urban planning industry … and improve the efficiency of operations and decision making' (Devlin, 2020, 59). This involves the use of data analytics, digitisation, automation, and AI/ ML to support land-use planning, community engagement, urban design, approval processes and transportation. On this, Beck (2019, 10) defines PlanTech as the 'range of technology influencing our cities' and, more generally, 'planning in a new digital world'. More specifically, Charlton et al. (2023) discuss the use of digital technologies for community engagement and note the interchangeability/ diversity of digital concepts including PlanTech. In their study, PlanTech contributes to smart engagement through enabling a digital-based dialogue between planners and the public (similarly, Hafferty et al. (2024) discuss digital engagement and participatory technologies for environmental decision-making). Finally, Daniel (2022, 13) describes PlanTech as the 'new wave of digital initiatives' and identifies ten key principles to 'help the planning profession navigate digital transformation'. The first of these principles relates directly to this article in that planners must 'be prepared' for significant changes in their everyday work.

On this digital transformation, Mualam et al. (2022, 1) note, '[t]he shift to online discussions and decision-making in planning is a phenomenon that is currently gaining traction across the globe' (in England see Wilson and Tewdwr-Jones, 2022; in Ireland see Kitchin et al., 2021; in America see Einstein et al., 2023, Meenar and Afzalan, 2023, Milz and Gervich, 2021; in Egypt see Megahed and Abdel-Kader, 2022; in Israel see Mualam et al., 2022; Daniel et al., 2024, and Potts and Webb, 2023, offer multiple case studies).[4] These terms have evolved Harris and Batty's (1993) initial conceptualisation of planning support systems (PSS) and are well connected to Geertman and Stillwell's (2020) PSScience framework. PSScience acknowledges the evolving but underexplored relationship between technology and planning, and suggests deeper investigation is required into three dimensions affecting PlanTech's utility in practice. These are the application arena within which PlanTech is used and the user characteristics, the governance context within which it will be used, and the instrument's design characteristics. The need to understand these characteristics and the evolution of PlanTech is evident in the UK with prominent PlanTech companies such as VU.CITY (www.vu.city/) and Commonplace (www.commonplace.is/) competing with PropTech companies to deliver digital planning technology services to government agencies, local authorities and other stakeholders.

On face value, it seems sensible to digitalise (parts of) the planning process to enhance systemic efficacy. However, notwithstanding the official spin, there remain

4 Daniel et al. (2024) surveyed planners in Australia, the UK, USA, New Zealand and Canada, Potts and Webb (2023) surveyed planners in Australia and the UK.

problematic and under-researched issues around democracy and inclusion, hidden algorithms, digital divides, and penetration of planning by neoliberal logics (Boland et al., 2022). In this article, following recent work by Daniel et al. (2024), Kitchin et al. (2021), Meenar and Afzalan (2023), Mualam et al. (2022), Potts and Webb (2023) and Wilson and Tewdwr-Jones (2022), we explore the extent to which planners are equipped with the requisite skills to adapt to and use new digital technologies. On this, a 2020 UK government White Paper argued that upskilling planning professionals to use the latest digital technology – allocating a key role for PropTech and PlanTech companies – would lead to 'significant enhancement in digital and geospatial capability and capacity across the planning sector' (MHCLG, 2020, 71). This is a difficult task given that the Digital Task Force report, 'identified a huge digital skills gap in planning authorities' across the UK (Batty and Yang, 2022, 7), a modern manifestation of the long-debated 'implementation gap' (Daniel et al., 2024). Moreover, Potts (2020) argues this is pertinent in an era of Planning 3.0,[5] whereby changing societal dynamics and the evolution of ICTs is catalysing a 'paradigm shift' in planning theory and practice. Similarly, in America, Milz and Gervich (2021) cite a significant 'learning curve' for participants in the planning process, notably amongst the public and professional planners.

As noted, current research exploring digital technology and planning professionals raises important questions about planners' preparedness to embrace digitalisation. In this article, we advance the conversation by providing a nuanced understanding of planners' preparedness by adding empirical evidence to the research record. To do this, we disaggregate planners not only *between* sectors, but also *within* sectors in order to excavate a finer-grained understanding of different types of planners' preparedness for using digital technologies, using Northern Ireland as a jurisdictionally special and unexplored geography, well placed to bridge the spatial gap between the aforementioned existing studies in England and the Republic of Ireland.

Methodology

The methodology for this article responds to Daniel et al. (2024, 418) who argue that 'further surveys should be undertaken' into professional planners' use of digital technology. In so doing, this study adopts a quantitative research design. Quantitative research is based on deductive analysis whereby variables are examined through statistical procedures, highlighting trends, capturing large datasets, and generalising

5 Moving beyond Web 1.0 and Web 2.0, Web 3.0 (versions 4.0 and 5.0 are in development) introduces more agentic technologies such as artificial intelligence and machine learning to make – and act upon – inferences from aggregated information, beyond connecting people with information and each other. Web 3.0 is predicated on the co-creation of content, huge quantities of data, information readable by machines, and use of algorithms to bring different forms of information together into useful groupings (Potts, 2020).

results (Berta et al., 2018). This study employed an online questionnaire to tease out planners' experiences of digital technology, partly replicating Daniel and Pettit's (2021) Australian analysis. We targeted planners in Northern Ireland and used prerequisite validation procedures to ensure that only planners over the age of 18 with experience of working in Northern Ireland could participate. As the research aimed to capture insights from across and within the planning profession, no other restrictions were set.

The online questionnaire included 28 closed-ended questions with pre-coded response options. This ensured effective analysis and comparable responses. A small number of open-ended questions were included allowing respondents to provide more detail on specific issues; for example, level of understanding of PlanTech. Responses to these questions were coded following a content analysis approach (Elo and Kyngas, 2008). This ensured that the questionnaire was designed to capture insights into generalised issues, delve deeper into key areas, and triangulate variables from respondents. This was crucial to verify the extent to which different contextual variables affect different groups of planners and their perceptions of digital technologies in their work. In doing so, we respond to Geertman and Stillwell's (2020) call for investigation into PSScience factors. The first half of the questionnaire investigated participant backgrounds: age, gender, sector of work, professional experience, role and educational history. This ensured identified variables could help unpack the contextual factors which affect planners' perceptions of the 'digital revolution' and, in particular, their understanding of PlanTech. The second half of the questionnaire investigated participants' use of digital technology, including identification of tasks supported, the types of technology used, their experience with technology, the extent to which technology helped them achieve better outcomes, and challenges encountered. These questions were designed using Likert scales, multi-modal options, and open-ended response boxes to minimise analytical difficulties while providing flexibility to ensure comprehensiveness (Silvia et al., 2014). Finally, participants were asked about their awareness of digital transformation in Northern Ireland and their expectations, challenges and recommendations for a future driven by PlanTech.

The questionnaire was created using Google Forms and was disseminated to a large potential participant pool on the professional networking platform LinkedIn and via email to key planning contacts in Northern Ireland's public and private sectors, including all 11 local authorities,[6] the Department for Infrastructure,[7] and

6 Antrim and Newtownabbey Borough Council; Ards and North Down Borough Council; Armagh City, Banbridge and Craigavon Borough Council; Belfast City Council; Causeway Coast and Glens Borough Council; Derry City and Strabane District Council; Fermanagh and Omagh District Council; Lisburn and Castlereagh City Council; Mid and East Antrim Borough Council; Mid Ulster District Council; Newry, Mourne and Down District Council.

7 The Department's role in the Northern Ireland planning system includes relevant legislation, regional policies and strategies and supporting practical guidance (www.infrastructure-ni.gov.uk/topics/planning).

the Planning Appeals Commission.[8] Additionally, a decision was taken to target early career and senior career individuals within every organisation, being mindful of age skewing (Mualam et al., 2022) and lack of responses from junior planners (Meenar and Afzalan, 2023). This was important to capture a reasonably representative dataset (Mascarenhas et al., 2014). Sixty questionnaires were distributed to potential respondents with a minimum response rate aim of at least thirty participants, again to capture representativeness (Daniel and Pettit, 2021). Overall, forty planners participated – double the number of responses obtained for an English study published in this journal (Wilson and Tewdwr-Jones, 2022). A response rate of 67 per cent for Northern Ireland is representatively robust, given it has a much smaller planning population compared to England and the Republic of Ireland. Key challenges with the questionnaire involved reducing unconscious bias, ensuring visibility to the target participants, and that participants interpreted the questions as intended given our lack of control over the responses (Creswell, 2003). Descriptive and median comparative methods (Bouzguenda et al., 2020; Fisher and Marshall, 2009) were employed to analyse the questionnaire datasets. This allowed key quantitative issues to be described and then variables compared through triangulation to investigate the impact of contextual profile factors on different groups of planners. All questionnaire data was imputed into SPSS, which facilitated robust comparative analysis.

Survey findings

A key component of exploratory research involves distilling representative participant demographic factors to make grounded inferences (Pruitt and Grudin, 2003). This was important given that Young et al. (2021) contend that planning technologies are developed without a deep understanding of the characteristics, attitudes, challenges and/or requirements of the target users, including planners. It was also important that the study investigated Northern Ireland to add an unexplored region to the international perspectives on PlanTech, particularly given Meenar and Afzalan's (2023) caution that planners' roles vary greatly based on the project context and work geography. They also explain that different societies possess different politico-economic power relations and ideologies that affect planners' capabilities in different locales. To support demographic unpacking, Young et al. (2021) recommend that persona dissections be used to build up representative planning profiles and to test profile variables, ultimately extrapolating characteristic dependencies. Therefore, the key profile variables identified from the data collection process are introduced before triangulation analysis on the extent to which these variables affect how different planners experience PlanTech.

8 The Planning Appeals Commission is an independent body which deals with a wide range of land-use planning issues and related matters in Northern Ireland (www.pacni.gov.uk/about-us).

Gender and age profiles

As shown in Table 1, our sample was balanced in terms of gender (47.5 per cent female and 52.5 per cent male). There was also a well-balanced mix of age groups with 55 per cent of participants under 35 years old compared to 45 per cent over 35 years old. Narrow age group categorisations were utilised to help correlate with the analysis of the career level variable. Including age, gender, and career level allowed us to add new insights on profile factors and build upon initial profile findings from previous studies (Kitchin et al., 2021; Meenar and Afzalan, 2023; Wilson and Tewdwr-Jones, 2022; Mualam et al., 2022). In this way, we can investigate the potential implications of combined structural barriers related to a male-dominated profession (Greed, 2020), something the professional institute for planners suggests is accompanied by ageism and inhibited career progression opportunities (RTPI, 2020). This also addresses PSScience's call for a multi-perspective investigation of personal and professional contextual factors affecting planning and technology (Geertman and Stillwell, 2020).

Table 1 Summary of research participants' age and gender

		Gender		
		Male	**Female**	**Total**
Age group	**18–23**	7.5%	7.5%	15.0%
	24–29	25.0%	5.0%	30.0%
	30–35	2.5%	7.5%	10.0%
	36–41	7.5%	12.5%	20.0%
	42–47	7.5%	10.0%	17.5%
	48 plus	2.5%	5.0%	7.5%
Total %		**52.5%**	**47.5%**	**100.0%**
Total no. participants		**21**	**19**	**40**

Sector, career level experience and role profiles

In terms of career profiling variables, Table 2 shows that 55 per cent of participants were private sector planners while 45% were public sector planners operating across local and central government.[9] Forty five per cent of participants were early career/ graduate planners while 55 per cent represented senior or director/ partner level planners. This composition of participating sectors and levels of seniority complements the surveyed career demographics and findings of Meenar and Afzalan's (2023) US study, who also included a mix of early career and senior career planners from

9 Government department (12.5 per cent) + local authority (32.5 per cent) = 45 per cent.

the public and private sector. This article delves further than Meenar and Afzalan (2023) by using these career profiling variables in later sections to analyse the impact on different levels of planners' preparedness for PlanTech.

Table 2 Summary of research participant sector and experience

		Career level			
		Early career / graduate	**Senior planner**	**Director / partner**	**Total**
Sector	**Private sector**	27.5%	12.5%	15.0%	55.0%
	Public sector government department or agency	7.5%	2.5%	2.5%	12.5%
	Public sector – local authority	10.0%	17.5%	5.0%	32.5%
Total %		**45.0%**	**32.5%**	**22.5%**	**100.0%**
Total no. participants		**18**	**13**	**9**	**40**

Crucial to our contribution to knowledge in dissecting the planning profession's preparedness for digital technology use, Figure 1 illustrates the variation of the planning fields researched. Relatively low numbers of participants across certain fields, such as biodiversity and ecology (2.5 per cent), urban design (2.5 per cent) and strategic communications (2.5 per cent) limits the representativeness of these samples. Nonetheless, the strong variability of participants in this research ensured that multi-perspective triangulation could be conducted to analyse the contrasting requirements from different specialisms, particularly where there was a high diversity of organisation types who participated. In our study, over twenty different organisations participated demonstrating that no one organisational culture or field dominated the findings. This is a key factor to overcome biased user profiling (Young et al., 2021) and to address the potential shortcomings of too broadly grouping the various roles performed across the profession. It also builds on Meenar and Afzalan (2023, 28) whereby their generalised findings suggested a 'sharp divide between people [planners] who see the value of smart technology and people who don't'. Our findings identify what type of planner fits each category more comprehensively than just public or private categorisations by relating the findings to their specific field and role performed. Furthermore, participants were asked to describe their role strategically and a content analysis (Renz et al., 2018) categorised the results within three key roles: Contributors[10] (50 per cent),

10 Contributors = planners who are contributing technical studies or new information to a project.

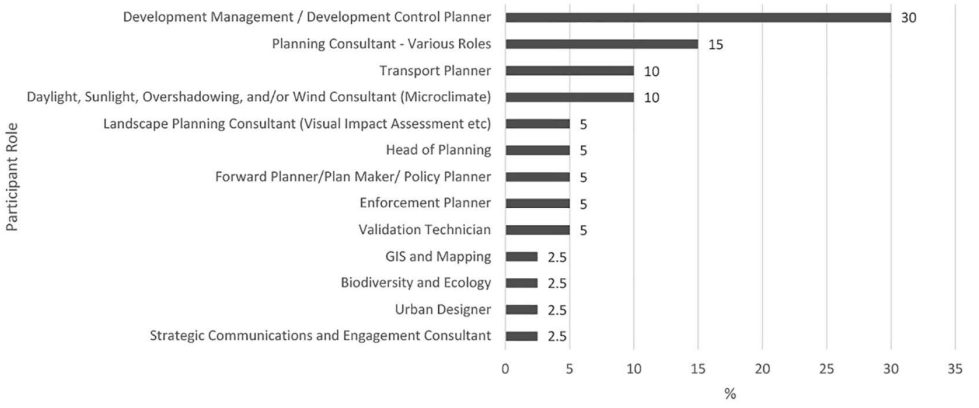

Figure 1 Summary of participant roles

reviewers[11] (34.2 per cent), and coordinators[12] (15.8 per cent). Categorisation was important to protect the analysis against dependency on the aforementioned lower participant numbers across individual planning fields and ensured that robust representative profile groups could be established to unpack the variability of key roles within the profession (Bødker et al., 2012).

Education profile

In terms of education, 22.5 per cent of the participating planners were educated to undergraduate Bachelor's degree level, 72.5 per cent to postgraduate Master's and just 5 per cent to PhD level. This variation allowed us to interrogate the role of educational backgrounds on PlanTech experiences. This was invaluable to add new knowledge to the PlanTech domain in that recent studies simply identify the importance that planners attach to new training and education programmes to enable the required transition to PlanTech use (Daniel and Pettit, 2020; Meenar and Afzalan, 2023; Wilson and Tewdwr-Jones, 2022). However, none of these studies explored the impact of historical education levels in preparing planners for PlanTech uptake, the direct and indirect planning skills acquired by different education levels that helped planners prepare for digital transformation, and conversely what skills planners are lacking by missing certain academic skills. Our study addresses these research gaps,

11 Reviewers = planners who primarily review work i.e. local authority development management or those in the private sector who review work before submissions.

12 Coordinators = planners who are typically coordinating how a project will be completed i.e. bringing together planning studies and project teams.

in particular Meenar and Afzalan's (2023, 33) recommendation that 'more research is needed to identify gaps between academic training and job responsibility as it relates to digital technologies'.

Contrasting perspectives, existing uses and preparedness for PlanTech

Having provided an overview of the core profile variables, the next section analyses the impact these variables have on how different planners use PlanTech, whether it meets their requirements, its importance to their role, and their preparedness for Planning 3.0. Mualam et al. (2022) argue little is known about the variability of perceptions of participants using ICTs in planning, and the following results begin to add substance to the issue of perception variability.

Gender and PlanTech

Applying a similar methodology to Bouzguenda et al. (2020), Alalouch (2018) and Jamieson (2004) in analysing Likert-scale data through the use of the median value, females (median = 5 i.e. very important, with an interquartile range (IQR) of 2) rated PlanTech more important to their roles than males (median = 4 with an IQR of 2). This is further pronounced considering that 58 per cent of female planners rated PlanTech as very important to their role compared to 33 per cent of males. Furthermore, significantly more males (38 per cent) felt that PlanTech did not meet many of their needs compared to females (5 per cent). In contrast, on average, 53 per cent of females stated that PlanTech met most or all of their needs compared to 38 per cent of males. Additionally, males felt more prepared for PlanTech and digital transformation in Northern Ireland (66 per cent = somewhat prepared or well prepared) compared to females (31 per cent). These results suggest that Northern Ireland female planning personas are more competent in using PlanTech within their existing roles to meet their user requirements compared to males. However, females do not feel as well equipped as males to deal with future digital transformation. Considering the macro-governance and application fields of PSScience (Geertman and Stillwell, 2020), this is a pertinent finding given that historically, gender power constructs limited female professional advancement into positions of power in planning (Greed, 2020) and their change management skills. This could obscure females' preparedness to diversify their use of PlanTech within different role scenarios as both males and females also felt that PlanTech was going to either change their role significantly (45 per cent) or quite significantly (42.5 per cent).

An RTPI survey corroborates the lack of experience in preparing females for new roles. It states, 'because women are the primary caregiver and take time out to have children, then they are disadvantaged as they do not stay in the system and get

the leadership experience they require to progress in their careers' (RTPI, 2020, 27). Without leadership experience and career progression opportunities, it can be inferred that gendered power structures contribute to the subjective differences between what males and females use PlanTech for, its importance to their role, and whether they are confident and have experience in diversifying PlanTech applications in the future. It should be noted, however, that the root factors for these differences in PlanTech perceptions and preparedness remain underexplored. This demonstrates the importance of going beyond studies of public and private sector planners (Meenar and Afzalan, 2023; Mualam et al., 2022; Wilson and Tewdwr-Jones, 2022), and instead testing the interdependency of numerous persona variables, such as age, planning roles and educational background before drawing conclusions. This is already well evidenced by the novel contribution above regarding the impact of the gender variable on PlanTech experiences in Northern Ireland. While previous studies have collected demographics related to gender (Mualam et al., 2022), they have not distilled their findings based on the participants' gender or triangulated their findings with other variable combinations in the same way as this research.

Age, career level and PlanTech

Crosstabulation of the age variable found PlanTech had important (median = 4.00) value to all participants roles. This adds to Geertman and Stillwell's (2020) theory that planning technologies are becoming ubiquitous across the profession. However, planners who have been in the profession for a long time did not find existing PlanTech to meet their needs to the same extent that those who relatively new to the profession did. Age group 18–23 indicated PlanTech meets most of their needs with the highest median rating all of the groups (median = 4.00) while the over-48 age group rated PlanTech as not meeting many needs (median = 2.00), the lowest median of all groups. Furthermore, preparedness declines between age groups 18–29 (median = 3.5) and 30–35 (median = 3.00). An anomaly then arises between ages 36–41. At this age planners indicated they felt somewhat prepared (median= 4.00), the highest rating of preparedness across all groups, before the declining trend continues to the 48-plus age group (median = 2.50). While the small sample size of each of these age groups means that these responses cannot be seen as representative, they suggest a possible trend and need for closer examination to explore the extent to which different age groups of professionals feel PlanTech meets their needs or feel prepared to use.

Considering the application environment of PSScience, numerous factors are likely to influence these relationships, including the fact that planners within the age group 36–41 would have started their careers during the advent of the 'digital turn' post-millennium (Ash et al., 2018; Batty, 2021). Therefore, they would have been exposed to sophisticated technology during their formative years and as their careers developed.

As such, they are well equipped with digital skills, experience in managing digital transitions, and are at a mature stage in their career. This may explain why preparedness declines between the 18–23 and 30–35 age group in that the ubiquity of digital technology post-millennium sees newer recruits of planners acquiring digital skills (Eynon and Geniets, 2015). Ultimately, this gives immediate post-graduation planners a sense of digital preparedness, and they find PlanTech important to their early-career technical tasks. However, this sense of preparedness declines as task complexity and role expectations increases with career progression until they finally master their role and associated tasks. The results suggest this occurs age 36–41 (median = 4.00).

In contrast, more experienced planners would have been established within their profession prior to the 'digital turn' when PSS/ PlanTech was considered 'specialist orientated' and 'specialist operated' (Geertman and Stillwell, 2020). As such, they may have not been exposed regularly to new technology (Potts, 2020), and, within their senior position of influence, may not have needed to or have resisted adopting emerging PSS/ PlanTech, something which potentially continues to affect their preparedness for future PlanTech adoption due to 'resilience resistance' (Shamsuddin, 2020). These differences in PlanTech experiences related to the age variable demonstrates a limitation of studies such as Mualam et al. (2022) who more broadly categorise the age of their survey participants (0–23, 24–55, 56+) and overlook the impact of more narrow age intervals on planners. These findings are corroborated by triangulating the career level variable. Director level planners, who are typically more experienced individuals, rated PlanTech as less important to their role (median = 3.78) compared to senior planners (median = 4.08) and early career planners (median = 4.11). However, as per the age variable, senior planners (likely mid-age group) felt more prepared for PlanTech than early career and director level planners.

Combined, these results concerning the age and career level variables suggest that while all generations typically recognise that PlanTech represents an important component to their role, the lack of tailored technology to pre-millennium planners' requirements reduces its added value, thus, confirming a skills and professional requirements gap exists across planning generations (Batty and Yang, 2022; Bouzguenda, 2021). Crucially, this research adds new knowledge in that it also illustrates the impact of the age variable pre- and post-'digital turn' and suggests that post-millennium planners' digital preparedness and user requirements is heavily connected to career maturity and their position of power. While early-career planners can be prepared to use new PlanTech in their role, they lack the position of power and experience to influence practices across other collaborating organisations. Therefore, they do not feel prepared or confident in their competencies to implement digital change despite recognising its strategic importance.

Education and PlanTech

It is important to interrogate the educational background variable, particularly as recent studies (Kitchin et al., 2021; Meenar and Afzalan, 2023; Wilson and Tewdwr-Jones, 2022) identify the impact of academic curricula and training as areas in need of future research related to PlanTech and digital transformation. The results indicate that Master's level (median = 4.00 with IQR 2) of educational backgrounds resulted in PlanTech meeting the needs of users better than Bachelor's (median = 3.00 with IQR 1) degree-educated planners. PhD level planners were discounted from this analysis due to low response rates from this educational category and, ultimately the lack of validity concerning representativeness. Nevertheless, the increase in rating indicates there is a relationship between the taught digital skills at undergraduate and postgraduate levels which are important factors in equipping planners to use PlanTech effectively, albeit education needs to improve at all levels. This correlates with Alamet et al. (2015) on the impacts of educational backgrounds on the digital divide at different academic levels.

We add to the findings of Alamet et al. (2015), with our study revealing an increasing relationship in planners' perceived level of preparedness towards PlanTech and digitalisation between those educated from undergraduate Bachelor's degree (median = 3.00 with IQR 2) to those with a Master's degree (median = 4.00 with IQR 1 prepared). Adding new knowledge to the academe, Figure 2 demonstrates that the aforementioned preparedness may represent a false sense of security in terms of planners' capacity within future digital planning arenas. The only future-oriented digital skills that most planners deemed themselves to have included GIS, data analytics, remote meetings and digital public engagement. In contrast, most planners indicated they did not have data coding/ science, 3D modelling, 2D modelling, technology procurement, IoT, algorithms, agile product development, UX design, scrum or digital facilitation skills, all of which were identified as areas of importance in the literature to operate within Planning 3.0 (Arciniegas et al., 2013; Bouzguenda, 2021; Potts, 2020; Shepherd and Doak, 2020). Planners' false sense of digital skills preparedness was also identified by Mualam et al. (2022) whereby they found participants' actions contradicted their perceptions: 90 per cent of participants reported the ability to adapt to virtual planning meetings, while 52.2 per cent reported technological difficulties in running the meetings. These complementary findings suggest future digital skills need to become part of all educational training programmes to increase awareness and preparedness. This addresses Meenar and Afzalan's (2023) call for investigation of the impact of academic curricula on planners' PlanTech preparedness and highlights the skills in most need of support. It also aligns with and builds upon the skills recommendations set out in the UK's Digital Planning Taskforce report and supports the suggestion that a new report from the Committee on Qualifications of Planners is well overdue and needs to account for a digital world and socio-technical transition (Batty and Yang, 2022).

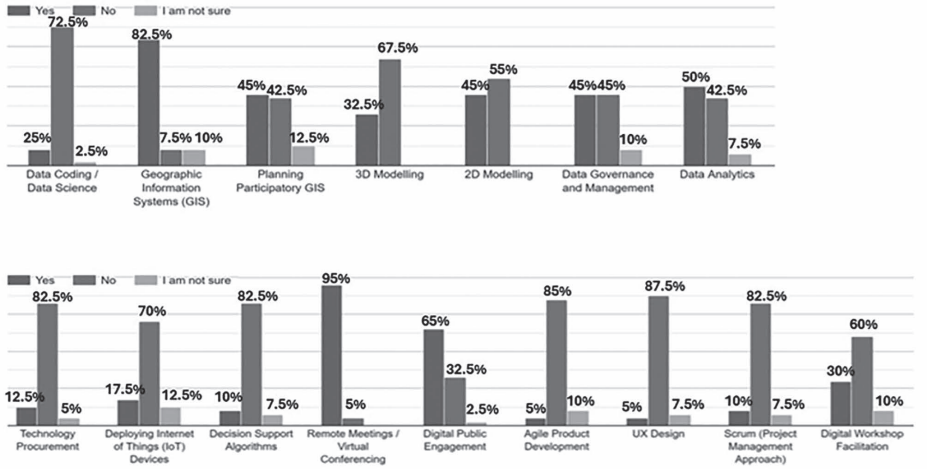

Figure 2 Summary of technologies which the participating planners have skills in using

Therefore, educational background plays an important role in PlanTech preparedness. However, ongoing training and regular exposure to various PlanTech types throughout a planner's career is fundamental to ensuring they continue to develop their skills competencies. Otherwise, the instrument component of PSS/ PlanTech must consider low digital proficiency and mask this by significantly reducing UX interface complexity.

Career variables: importance and meeting user requirements

Planners by career sector

It was then crucial to deduce the impact of career variables on planners and PlanTech. Median crosstabulation of the career sector variable found that PlanTech was of more importance to local authority (median = 5.00 and IQR = 2) and central government (median = 4.50 and IQR = 2) public sector planners compared to private sector planners, (median = 4.00), albeit the median analysis indicated that each sector found PlanTech at least somewhat important to their role. However, while public sector planners found PlanTech to be important to their role, on average PlanTech did not meet many of the user requirements of public sector planners within central government (median = 2.00 with IQR = 2.00). Slightly improved, public sector local authority (median = 3.00 with IQR = 1) and private sector (median = 3.00 with IQR = 1) planners felt PlanTech was of average use in meeting their user requirements.

Combined, these results suggest that PlanTech is not meeting user requirements for public or private sector planners despite its importance to their roles.

Furthermore, the results indicated that public sector local authority planners (median = 4.00 and IQR = 1.00) felt slightly more prepared than both public sector central government (median = 3.50 and IQR = 2) and private sector (median = 3.50 and IQR = 3) planners for digital planning transformation. This contrasts with Kitchin et al. (2021) on the Republic of Ireland which suggested that due to public sector austerity, private sector planners were more prepared for PlanTech use. The difference between geographies could be partly influenced by the fact that Northern Ireland local authority planners have been anticipating the release of an updated national digital planning portal since 2020, and therefore there has been some local authority training programmes, user acceptance testing and preparing for change plans (Ards and North Down Council, 2022). This may have helped to at least create a heightened sense of preparedness for local authority planners. This is potentially significant given that recent Planning Portal newsletters (Planning Portal, 2022) reveal that private sector planners were not provided with the same opportunity to attend these closed training sessions in collaboration with the public sector, despite the portal being a fundamental component to a collaborative digital revamp of planning in Northern Ireland. Other explanations include the fact that strategic planning applications in the Republic of Ireland, typically led by private sector consultants, are mandated to create project websites for public transparency, and historically this has not been required in Northern Ireland. Thus, the planning governance context requires private sector planners to embrace technology within their roles in the Republic more so than in Northern Ireland (An Bord Pleanála, 2022). This also highlights the importance of further dissecting the career variables to understand the subjective differences between users in Northern Ireland and illustrates the impact of geographic-specific contextual factors on planners' PlanTech preparedness.

Planners by planning field

Table 3 provides a comparison of the average importance of PlanTech across ten planning fields and whether it meets user requirements within those specific fields. Crucially, while PlanTech is important to most fields of planning, it is currently only meeting most of the needs (median = 4.00) of planners involved in enforcement planning and urban design. Additionally, contrary to the level of focus that recent literature attributes to engagement and consultation PlanTech (Geekiyanage et al., 2020; Kleinhans et al., 2022; Mehmood and Imran, 2021), strategic communications planners rated PlanTech of least importance to their field (median = 1.00). This may indicate that Northern Irish communications planners value non-digital methods of engagement more highly than digital methods. This is something which correlates

with Zheng and Sieber (2020), i.e. that human interaction should not be displaced by digital tools, and Boland et al. (2022), i.e. that digitalisation alone is not the solution to equitable engagement and social justice requirements.

Table 3 A comparison of median importance of PlanTech across ten planning fields and whether they meet user requirements

Planning Roles	PlanTech importance – median*	Equates to	PlanTech meets needs – median	Equates to
Daylight, sunlight, overshadowing, and/or wind consultant (microclimate)	4.50	Important	2.50	Does not meet many needs
Development management / development control planner	4.50	Important	3.50	Average
Enforcement planner	4.00	Important	4.00	Meets most needs
Forward planner/policymaker	5.00	Very Important	3.50	Meets some needs
Head of planning	5.00	Very Important	3.50	Meets some needs
Landscape planning consultant (visual impact assessment etc)	4.00	Important	2.50	Does not meet many needs
Planning consultant – various roles	4.00	Important	3.50	Average
Strategic communications and engagement consultant	1.00	Not very important	3.00	Average
Transport planner	4.50	Important	3.00	Average
Urban designer	3.00	Average	4.00	Meets most needs
Validation technician	3.50	Average	3.00	Average

These findings again demonstrate the importance of better understanding the subjective differences between planners, their fields, and roles, and not making biased assumptions about user needs without evidence, particularly when designing PlanTech (Young et al., 2021). It also demonstrates once again the importance of further unpacking the planning profession beyond broad categorisations of the public and private sector. While key contributions (Meenar and Afzalan, 2023; Mualam et al., 2022; Wilson and Tewdwr-Jones, 2022) have identified differences across the public and private sector related to their PlanTech preparedness, our contribution enriches these works by more directly highlighting the composition of how these sectors are made up, and in so doing better identifies those planning fields that are in most need of, or most suited to, PlanTech support. The findings also support suggestions that there are differences in the complexity and user friendliness of different discipline-specific planning technologies that impact different types of planners' experiences

with technology (Pelzer et al., 2014). This is particularly important given this research's triangulation of personal contextual variables to evidence interdependent factors of age, gender, career level and role on planners' preparedness and competencies.

Planners by role categories and user tasks/ requirements

Recognising the complex overlap of activities performed by planners across various planning fields, it is worth dissecting planners by the role they perform within their field. Herein, PlanTech was found to be more important to those planners performing coordinator (median = 5.00 and IQR = 1) roles compared to contributors (median = 4.00 and IQR = 2) or reviewers (median = 4.00 and IQR = 2) roles. However, reviewer (median = 4.00 with IQR = 2) planners felt that PlanTech met their needs better than contributor (median = 3.00 with IQR = 2) and coordinator (median = 3.50 with IQR = 2) roles. This suggests that contributors are in most need of tailored PlanTech to support their technical functions. Figure 3 compares the planning tasks and uses of PlanTech across planning roles. While there are priority use case commonalities across all roles including reviewing maps/ drawings and producing outputs and reports, there were also key differences that demonstrate the variability in tasks performed, highlighting the importance of avoiding a generalised interpretation of digital reform requirements. For example, coordinators (83 per cent) and contributors (69 per cent) both applied high importance to creating maps, while this was unimportant to reviewers (8 per cent). Additionally, reviewers rated using technology to validate planning applications (69 per cent) as important, while this was fairly unimportant to contributors (26 per cent) and totally unimportant to coordinators (0 per cent).[13] This level of variability is evident across all roles and emphasises the importance of comprehensive targeted research prior to PlanTech design.

To complete these tasks, and better distil what the existing PlanTech ecosystem is in Northern Ireland, Figure 4 dissects the types of PlanTech used by planning role categories. Word processors, spreadsheets and presentation software were rated within the most used PlanTech types across all planner roles. This adds new evidence to Russo et al. (2018) on their contention that PlanTech – which replicates non-digital approaches to general tasks of communication and calculation and data analysis – remains the focus of planners' user needs. However, discounting general office software (Word, Excel, PowerPoint), contributors predominately use online maps (100 per cent), data portals (74 per cent) and GIS (68 per cent). Coordinators use online maps (83 per cent), GIS (67 per cent), and equally graphics packages (50 per cent), social media (50 per cent) and remote meeting (50 per cent). Reviewers prioritise online maps (85 per cent), GIS (77 per cent) and remote meeting (69 per cent). There

13 The percentage represents the total number of planners by their role who select an option.

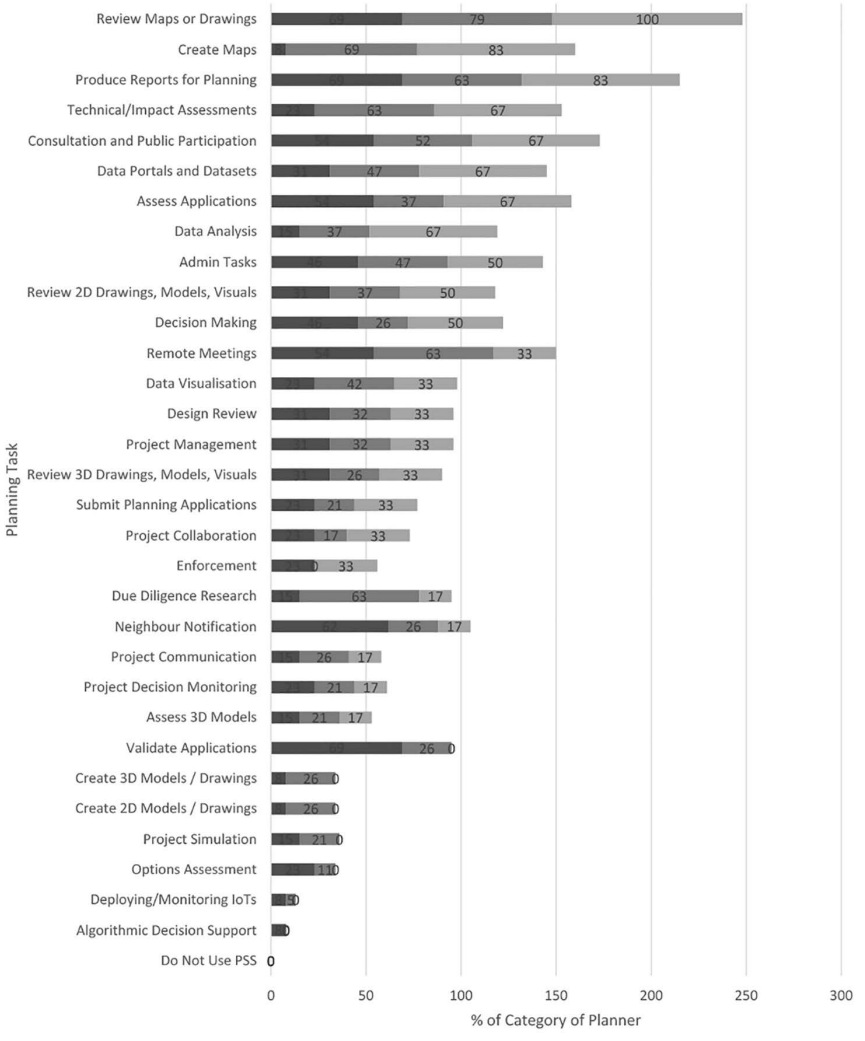

Figure 3 Planning tasks and uses of PlanTech across planning roles

is significant variation in the uses of 2D and 3D design software, project management software and digital twins. As such, while there are commonalities, there are clear deviations in uses across all roles that reveals the need for PlanTech designers to engage with target users to understand their added value requirements (Young et al., 2021). This again suggests the need for a co-design PlanTech approach (Ferraro et al., 2015).

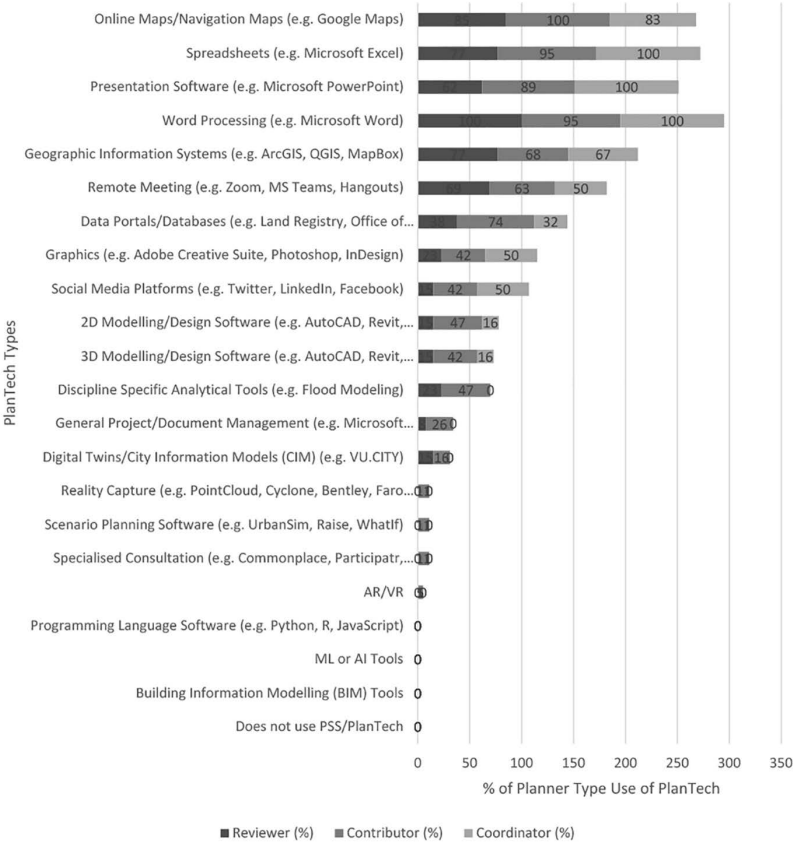

Figure 4 Types of PlanTech used by planning role categories

Combined, the above has unpacked the impact of personal contextual profile variables on Northern Ireland planners' existing adoption and use of PlanTech in practice, along with their experience as to whether PlanTech is meeting their user requirements. The analysis confirmed that all personal variables are interconnected, playing strong roles in varying planners' experience and requirements across the profession. This is something which has been significantly underexplored in PlanTech literature and design to date (Geertman and Stillwell, 2020; Young et al., 2021). In particular, gender and career variables (i.e. role, field, seniority) represent significant profile components, potentially influenced by traditional power constructs, that affect the tasks that planners inevitably perform and for which they need PlanTech. Combined, these results confirm the need for dissection of different planning profiles'

value added needs and their level of preparedness when designing PlanTech to overcome the planning technology adoption and implementation gap.

Conclusions

In this article, we contribute to discussions in this journal on planning and technology (Goode, 2021; Milz and Gervich, 2021; Ormerod and & Davoudi, 2021; Wilson and Tewdwr-Jones, 2022). More specifically, we address a gap in the research whereby '[f]ew previous studies have sought planners' perspectives on their future use of technology' (Daniel et al., 2024, 417). During and after the pandemic, the integration of digital technologies into planning processes may be recalibrating how planning functions and how planners operate, often in subtle and unseen ways. Batty and Yang (2022, 4) argue the digital transformation of planning in the UK requires new ways of thinking and doing planning work, necessitating a 'digitally enabled spatial planning profession'. A key line of investigation is the level of preparedness among planning professionals to adopt and adapt to PlanTech (Kitchin et al., 2021; Meenar and Afzalan, 2023; Mualam et al., 2022; Wilson and Tewdwr-Jones, 2022). This article offers additional details and insights by exploring differences between and within planning sectors that can enhance our understanding of planners' (in)ability to use digital technology. Our findings suggest that there is still an implementation gap in the appeal for PlanTech and planners' preparedness to use it in practice. This finding reaffirms the work of others, and our study adds additional knowledge by disaggregating and analysing the demographics and competencies of different types of planners by age, gender, seniority and skills. For example, public sector planners appear to be less prepared than their private sector counterparts, and while female planners were generally more enthusiastic about PlanTech than men, they were not as prepared overall. Moreover, they were less likely to carry that enthusiasm into management positions in which they might introduce more innovation into planning institutions. These details are an important contribution when combined with findings from surveys of planning professionals in the UK, and beyond.

In terms of geographical proximity, studies examining planners' preparedness for digital technology use have focused on England and the Republic of Ireland. This study of an unexplored smaller region in the UK and on the island of Ireland offers unique insights into the perceptions and competencies of planners to engage with digital transformation. In terms of our contribution to knowledge, we present a more fine-grained analytical unpacking of the planning profession than is found in other studies. In terms of enhancing our understanding of planners' preparedness for digital technology, a key finding is that different types of planners have different perceptions of and competencies to use PlanTech. Reinforcing other studies, we find that planners require significant upskilling in their digital skills and, additionally, it is important to recognise the different

needs of different planners. This is especially true when considering curriculum and training. Only PhD level planners appear to be equipped to implement PlanTech in practice, based on our results. Planners not earning a PhD were less prepared overall. Moreover, while communications planners indicated PlanTech as being unimportant in their work, other types of planners saw PlanTech as much more important, including those involved in forward planning, transport planning, development management and those operating as heads of planning.

Given the different needs of practising planners included in our study, planning graduates should acquire a broad set of digital skillsets during their training to prepare them for an increasingly digitalised profession. However, given the rate of rapid change, our survey results strongly suggest that planners' digital skillsets must move beyond the narrow analytical and document production skills cultivated over the last three decades. Beyond Northern Ireland, the key message for planning theory and practice is that future research must be cognisant of this variability in planners' adoption of and adaptability towards PlanTech if it is to be a viable tool in planning processes. The alternative is that planners may cede important professional domains to computer scientists, programmers, etc, individuals, in other words, who may lack the ethical and practical skills that distinguish planners from other professions who affect the future of the natural and built environment.

To date, our understanding of planners' preparedness for digital technology has rested on surveys that differentiated planning by sector: i.e. public, private and (in some studies) voluntary. The added value of this study is that it drills down much further to reveal a richer understanding of the contextual factors and variables that inform how different types of planners are able to respond to PlanTech. Recent interventions in the literature have conceptualised these major transmutations as the 'digital revolution' (Wilson and Tewdwr-Jones, 2022), the 'planning-technology nexus' (Boland et al., 2022) and Planning 3.0 (Potts, 2020). The empiricism of this article begins to ground truth to our understanding of what these conceptual frameworks mean for planning students, planning professionals and planning educators. The findings add depth to our understanding of how the 'digital revolution' is experienced by different types of planners, and what is required to ensure that in the future planners are more able to adopt and adapt to PlanTech and manage the transition to Planning 3.0. In terms of the 'planning-technology nexus', this article deepens our understanding of how this relationship is played out, its growing significance and the internal dynamics within and between different planning sectors. In conclusion, the implications of this article move beyond the case in question and contribute more widely to international debates in planning theory and practice driven by Planning 3.0 and the 'digital revolution' in a meaningful manner. It adds new knowledge and informed insights into the preparedness of the planning profession for PlanTech that have relevance for professional planners around the world.

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