Digital disruption and planning - Use of data and digital technology by professional planners, and perceptions of change to planning work

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In an era of smart cities and digitalisation, there is plethora of digital government and digital planning initiatives. Such rapid digitalisation is putting the planning profession under pressure to adapt to new digital technology. Our research investigates the use of data and technology, perceived and desired outcomes from arising from digital disruption, and perceived barriers to the adoption of new technologies to in day-to-day planning work from the point of view of practicing planners across a wide range of professional roles. This paper reports the results of a mixed methods study involving both a survey and workshop, with participants located primarily in the state of New South Wales, Australia. Our research finds that widespread digital disruption is anticipated by most participants and provides important evidence to assist planning organisations in preparing for this change.

Keywords: digital planning, digital government, ePlanning, plantech, planning support systems, digital disruption, smart cities

Introduction

Recent years have seen a new wave of digital innovation strategies and initiatives in government departments across the globe. With most professional planners operating in, around or interfacing-with government, planning is no exception to these trends, bringing the planning profession under pressure to adapt to new digital technology that has the potential to substantially change or automate many existing planning tasks – a process commonly referred to as 'digital disruption' or 'digital transformation'. These initiatives are enabled by continual improvements to technology which in recent years have passed a threshold making it relatively easy to collect, process, share and visualise 'big data' on a city-wide scale (Daniel 2020).

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In many places the creation and implementation of these digital innovation strategies have been driven by the establishment of new digital service teams within government departments across the world, one of the earliest examples being the Government Digital Service (GDS) of the UK Government, whose success has sparked similar initiatives around the world (Mergel 2019; Evans et al. 2019). These new entities are defined by Mergel 2019 as “organizational structures that are focusing on the redesign of services and processes with the goal to provide digital government services faster and in a more user-centric way than existing e-government efforts”. Recent years have also seen the establishment of similar organisations specifically focused on driving digital planning efforts. These include the ‘Future of Planning” program by the Connected Places Catapult – a publicly funded research and development organisation which works with a number of local authorities and national agencies (Devlin 2020), the Digital Land Team in the UK Ministry for Housing, Communities and Local Government, and the New York City Planning Labs within the Planning Department of New York City in the USA. Alongside these public sector initiatives, several new software start-ups have begun to emerge with products aiming to significantly improve and disrupt the existing systems of planning authorities (Connected Places Catapult 2020).

Aims

Despite the recent wave of new digital planning initiatives, little up to date scholarly research has been published exploring likely systematic changes and impacts on planning practice from the point of view of professional planners. Using a mixed methods approach this study asks practicing planners:

(1) How they currently use data and digital technologies in their day to day work.

(2) What changes they anticipate in the near future.

(3) The barriers they identify to these changes occurring.

(4) How prepared they feel for any anticipated changes.

This paper reports on the results of a survey with n=84 respondents, and a workshop with n=16 participants undertaken in 2019 in partnership with the Planning Institute of Australia as part of their efforts to formulate a response to inform their advocacy and education activities in the face of digital disruption, offering valuable insight into the likely shape of changes and the preparedness of the industry. The study was undertaken primarily in the context of the state of New South Wales (NSW) in Australia. In recent years the NSW Government has established its own digital service team and embraced an ambitious digital transformation agenda (NSW Government 2019) including investment in a new online Planning Portal (NSW Government 2020), Spatial Digital Twin platform (NSW Government 2020a) and Smart Places Strategy (NSW Government 2020b).

This study put an inward-looking lens to the topic of digital disruption in professional planning practice, asking participants to reflect on technology used in their day-to-day work rather than the effect new digital technologies may have on the form and function of the urban environment itself. It nevertheless otherwise took a role-agnostic approach, asking participants to self-identify the tasks and processes undertaken in their day to day work. Participants in the study represent a wide variety of planning roles from development assessment, policy making, urban design, environmental planning, and many others.

Background

Historical application of digital technology in government and urban planning

Although we are currently experiencing a new wave of digital government initiatives, it is important to remember that the adoption of digital technology in government is not new, and neither are the high expectations that accompany the early stages of implementation for a given technological development (Linden and Fenn 2003; Lips 2020). This pattern is evident right from the beginning of digital computing history when World War Two saw the development of early general-purpose digital computers for that calculation of missile trajectory calculation and codebreaking (Ceruzzi 2012). Almost immediately post war this new technology was put to work by government departments for clerical and statistical purposes (Agar 2003).

Urban planning was included among the earliest applications for these new digital capabilities. This period saw the development of several large-scale urban models, coinciding with a post-war optimism in rational-comprehensive and systems methods of decision making (Batty 2008). The Chicago Area Transport Study is a prominent example - commencing in 1955, the team used a computer to run a model that calculated the propensity for people to move from A to B for any two of hundreds of locations across the city (Black 1990; Plummer 2003). At this time computing technology lacked the capacity to store this information in digital memory, storing all outputs in paper print-outs (Plummer 2003).

As many of these large these early large-scale urban modelling exercises failed to live up to expectations, confidence in rational comprehensive methods of planning was diminishing. On the quantitative front there was widespread recognition that the models were unwieldy and severely limited in their predictive ability against the sheer complexity of real-world urban systems (Lee 1973). On the qualitative front came much wider recognition in planning theory of planning as a political process (Forester 1989). Although statistical practice and urban modelling research continued, these methods were side-lined in normative theory in favour of communicative models of planning (Healey 1992).

Implementation of computing technology nevertheless continued to accelerate through the spread of mainframe computing in the 1970s and 80's through to personal computing in the 1980s and 90s. This resulted in the change or wholesale replacement of many clerical and administrative tasks performed in professional roles both inside and outside government (Fountain 2003). More specifically important to planning, the 1990s saw the growing adoption of Geographic Information Systems (GIS) - digital mapping software that promised significant improvement to the ease of accessing and communicating spatial information (Campbell and Masser 1992; Nodovic-Budic 1997; Budić and Godschalk 1994). This later era also coincided with the start of new public management (NPM) reforms in governments worldwide, which saw the disaggregation of many government functions to smaller agencies and the introduction of competition and incentive schemes in the delivery of government services (Dunleavy et al. 2006). This resulted in the outsourcing of many ICT functions which many digital government scholars argue side-lined consideration of technology as a tool to achieve reform of core governance functions (Dunleavy et al. 2006; Mergel 2019; Lips 2020).

The introduction of the internet in the 1990s brought a new wave of high expectations in the late 1990s and early 2000s around the potential for technology to radically change the way governments operate through successive paradigms of e-government, government 2.0, open government and digital government (Meijer, Curtin, and Hillebrandt 2012). These visions range from purely technocratic perspectives of improved efficiency through the provision of ‘joined-up’ services as facilitated by online transactions (e.g. Layne and Lee 2001) through to broader notions of reform for open government and e-democracy (e.g. Alexander and Pal 1998; Ferdinand 2000).

The term ePlanning arose in the late 1990s and 2000s alongside these broader eGovernance initiatives. In professional practice ePlanning referred to widespread (and in some places, ongoing) efforts to make planning information and associated regulatory services available online. In scholarly work the emphasis is slightly different, with the journal of ePlanning focused more on exploring the use of digital technology to assist with community consultation and collaboration activities - in line with normative communicative planning theory (Silva 2010).

Ever increasing digital capabilities in computer processing power, digital storage and internet speeds the last decade has seen yet a new wave of expectations around the impacts of big data and associated on government decision making and service delivery (Lips 2020). This period has seen the rise of the smart cities movement (Townsend 2014), although this body of work tends to focus on the capabilities offered by IoT devices for the real-time management of the city, and less on the use of technology for long-term strategic planning and development regulation activities which are the bread and butter of planning practice. More closely aligned to the typical interests of planners, the fields of urban modelling, planning support systems (PSS) and other work around human-computer interaction, have experienced a resurgence of interest alongside greater access to data and improved feasibility of computationally intensive methods of analysis (Geertman et al. 2015; Pettit et al. 2018). As documented in hundreds of publications (see for example Schroeter, Foth, and Satchell 2012; Lambton-Howard et al. 2019; Pettit, Tanton, and Hunter 2017) , this body of work typically involves the development of new analytical models, software or devices designed to assist with various urban planning tasks with most addressing a single or narrow range of planning tasks, rather than the planning process as an entire regulatory system.

Empirical research into the adoption of digital technology in government and urban planning

These successive waves of high expectations, and the large body of scholarly work in the development of new methods and tools, illustrate the need for continual empirical research to collect and critically evaluate evidence to the extent to which they have been realised or implemented in practice. Only in doing so will it be possible to characterise barriers and challenges to inform solutions that may achieve in practice the normative goals of digital government and digital planning scholars. In empirical research to date it is recognised that many of the aspirations for widespread reform have not been realised, with some scholars suggesting that technology deployment decisions tend to be made by senior manages for whom are incentivised to reinforce existing structures of communication, authority and power (Kraemer and King 2003). Whilst many of the more utopian goals of collaborative governance are yet to be achieved, Evans et al. 2019 report substantial progress in Australia towards what the authors term "Digital Era Governance", a post-NPM paradigm which involves a 'digital first' or 'digital by default' approach to deliver better and more seamless government services (Dunleavy et al. 2006). After a series of interviews the authors identify greater support from senior political leadership, conditions of austerity and cost-containment measures, and widespread improvement to digital literacy in the general population as the main driving forces behind this change.

For urban planning specifically, studies into the actual day to day use of digital technology were first prominent in the 1990s and early 2000s and focused primarily on the adoption of GIS technology (French and Wiggins 1990; Campbell and Masser 1992; Brown 1996; Merry, Bettinger, and Hubbard 2008; Göçmen and Ventura 2010; Nodovic-Budic 1997; Gilfoyle and Wong 1998). The more recent studies have shown that GIS, and the related web-mapping applications that have since been developed, have now become common feature of planning courses and workplaces throughout the world (Olafsson and Skov-Petersen 2014; Williamson and Parolin 2013) although its use may be limited to information search and retrieval functions rather than more advanced analytics (Göçmen and Ventura 2010; Merry, Bettinger, and Hubbard 2008).

Despite continual improvements to digital capabilities, fewer studies into the actual use of technology by urban planners have been published in recent years. Those that have been publish suggest that whilst the adoption of ICTs for administrative tasks is well progressed, the use of specialised software such as planning support systems (PSS) (Russo 2017; Williamson and Parolin 2013a) and community engagement devices and platforms (Fredericks and Foth 2013; C. Pettit et al. 2018; Williamson and Parolin 2013b; Houghton, Miller, and Foth 2014) is still limited. Whilst many studies show promising results, the large gap in tool development and their actual use in planning practice, has been long noted in the PSS literature (Vonk, Geertman, and Schot 2005; Vonk and Geertman 2008), with recent studies further attributing this gap to the limited involvement of planning practitioners in the original design and development of many digital tools (Vonk and Ligtenberg 2010; Russo et al. 2018a).

This study provides not only a timely update to existing literature outlining technology used by Australian urban planners, but importantly also asks planners what changes they both anticipate and desire arising from new technological capabilities, independent of the consideration of any specific task, tool or software application. This is an important new contribution for which our research makes in identifying the trends and issues perceived by professional planners themselves to be the most relevant to their day to day work.

Methods

This paper reports on the results of a survey (n = 84) and a focus-group workshop conducted in September 2019 which comprised 16 participants. A convergent-parallel mixed methods approach was taken in order to investigate the issue in-depth and from multiple angles (Creswell 2009). The survey provides a broad and robust indication as to the extent of technology use in planning practice and expectations of and readiness for change, whilst the focus group allowed for in-depth interrogation of current planning processes in the context of individual projects and tasks commonly undertaken by professional planners in their work.

Similar to previous studies (Merry, Bettinger, and Hubbard 2008; Williamson and Parolin 2013b; Russo et al. 2018b), the survey contained a mixture of closed and open questions, thirteen in total, with a further six demographic questions. A copy of the survey instrument is attached in the supplementary material. The survey was administered online from mid-August to the end of September 2019 using the Qualtrics platform which allows for secure data storage on Australian servers. It was advertised to all members of the Planning Institute of Australia in the regular online e-mail news bulletins of the organisation and promoted online via social media channels during the period of the survey. The survey received 84 responses, primarily from NSW as shown in Figure 2. Breakdown of employment and experience variables of study participants. below and it is estimated to represent the views of the population of employed planners within the State with a 13% confidence interval[1]. Descriptive and comparative statistics were used to analyse the data and, although the raw data cannot be provided for reasons of confidentiality, the script written in the R programming language that was used to perform the analysis is available at XXXXX in order to facilitate reproducible research for any future surveys. Comparative statistics were used to investigate differences between different groups of planners based on their responses to demographic and employment questions, such as between public and private sector planners or strategic and development assessment (DA) planners. A full record of all the comparison groups tested is attached in the supplementary material. Almost none of the collected data was found to be normally distributed and therefore the following standard non-parametric methods were used to detect if there were significant differences in results between groups of participants (e.g. public and private sector planners). For interval responses (i.e. five-point scale likert questions) the Wilcoxon Rank Sum test was used to compare the group means for two groups, and the Kruskal-Wallis test to compare group means for more than two groups. For categorial responses (i.e. software and data usage) Person's Chi-Square test was used to compare two groups and Log-Linear Analysis was used where comparison between more than two groups was required. A thematic

[1] 3,630 urban and regional planners, 4-digit OCCP, Australian Bureau of Statistics 2016 census.

analysis was undertaken on the answers to open questions with the assistance of the qualitative analysis software NVIVO, according to the principles and process outlined in Braun and Clarke (2006). An inductive approach was taken to coding the material based on a semantic reading of the answers given, with a large number of themes identified in early iterations of reading through the material. These themes were then consolidated in an iterative review process resulting in a series of concept maps representing a concise, descriptive summary of the answers given to each open-ended question. These results were then interpreted in light of the remainder of the survey and workshop findings, and the broader literature. The coding schema is provided in the supplementary material.

The focus group workshop was held in the City Analytics Lab at UNSW, a purpose built facility to support planners to interact with an array of digital planning tools (Punt et al. 2020). The workshop was attended by thirteen participants with three supporting facilitators. The participants were dived into three self-identified groups based on commonalities in employment experience. The intent of the exercise was to identify areas of consensus among participants. Each group was assigned a facilitator and then asked to work through a series of activities. The output was recorded by the facilitators and participants on the interactive map tables available in the lab, which performed a similar function to standard brainstorming materials such as post it notes and butcher's paper, with the advantage of improved interaction and complete digital record (Figure 1. Images from workshop activities showing use of interactive tables). The activities were undertaken sequentially as follows and a complete copy of the stimulus presentation is included in the supplementary material:

(5) Brainstorming what does good planning look like? what are we trying to achieve?

(6) Constructing a workflow diagram of typical projects undertaken by the group.

(7) From the overall workflow diagram, mapping out a specific common task in more detail.

(8) Brainstorming a digital solution that would improve the outcomes of the chosen task.

Figure 1. Images from workshop activities showing use of interactive tables

At the end of the workshop a recorded group discussion took place where facilitators were asked to reflect on the results of each of the activities. All material gathered from the workshops was transcribed and thematic analysis was undertaken on the material as per the process outlined for the open-ended survey questions above.

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To allow for comparison between the two activities responses to the same demographic and employment questions were collected from both the survey and focus-group workshop participants. A summary is provided in Figure 2. Breakdown of employment and experience variables of study participants. below.

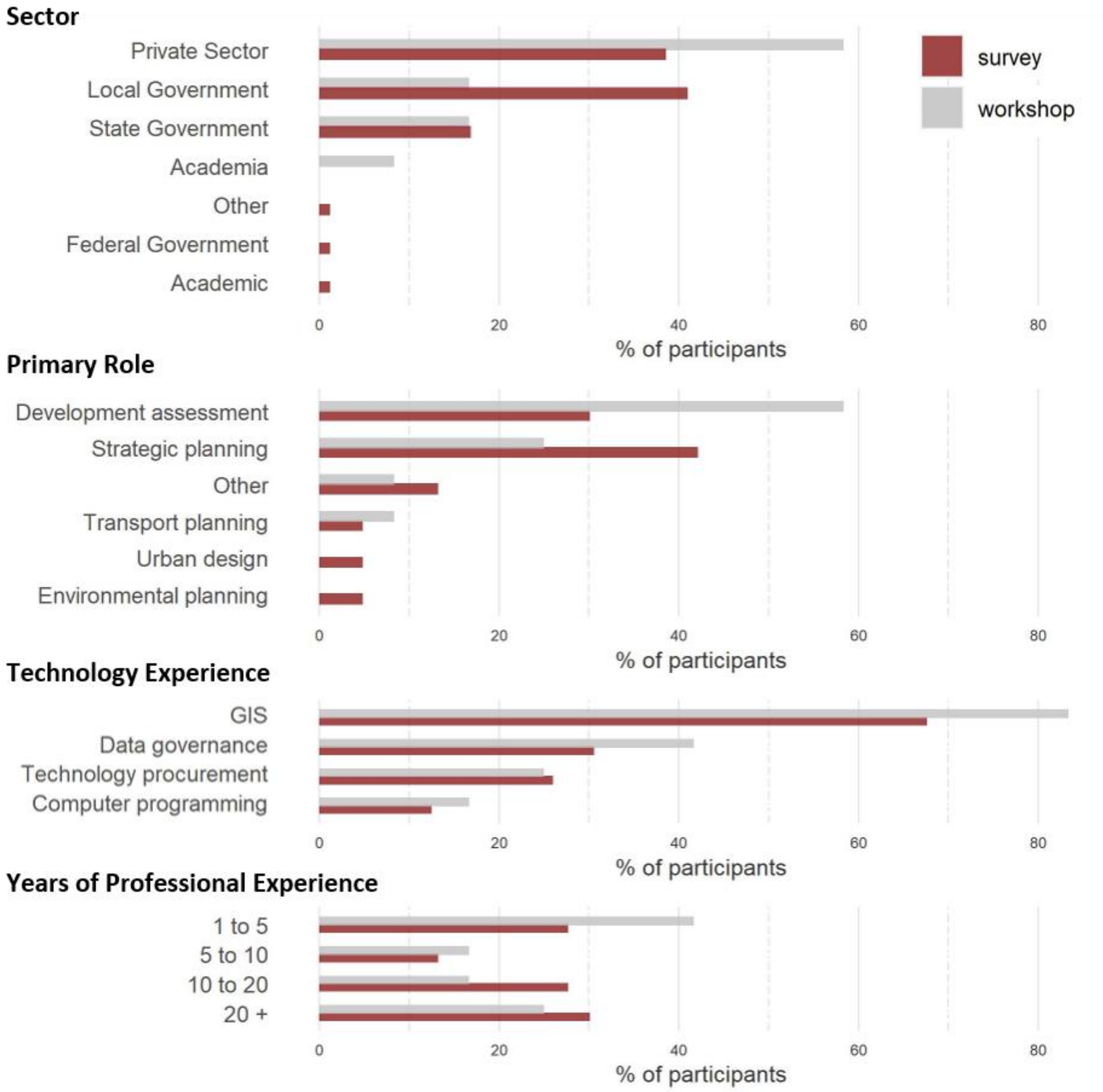

Figure 2. Breakdown of employment and experience variables of study participants.

Limitations

It is recognised that there are several limitations in the study design that must be considered when interpreting the results. All participants were self-identified and recruited online, potentially skewing the results to those who are more tech-savvy or at least interested in the topic. It is also recognised that the sample size of the survey is small, therefore limiting the ability to detect statistically significant differences in between-group comparisons for the quantitative evaluation component of this research.

Survey Results

Sources of data used by planners

Survey results show that traditional institutional data sources, such as the Australian Bureau of Statistics (ABS), remain the predominant source of information in the work of planning professionals (Figure 3). Despite technology industry discussion around big data, more novel data sources are shown to be low on the list. Results show modest usage of social media data and very low usage of data sourced via the Internet of Things, that is networked devices equipped with environmental sensors that are commonly the focus of smart cities initiatives.

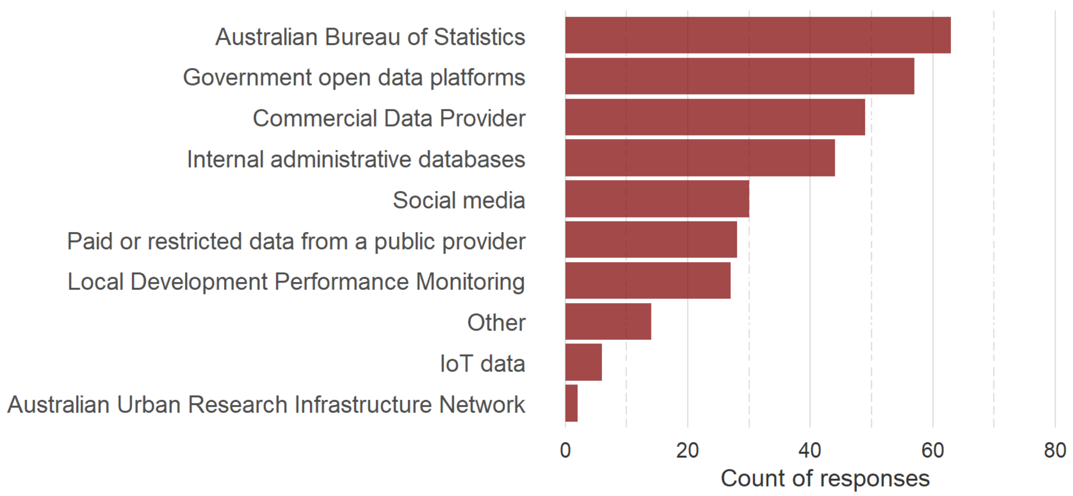

Figure 3. "What sources of data do you use in your current role? Horizontal bar chart by count of responses."

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Statistically significant results from the comparison of different groups of respondents show largely expected role-based differentiation in the sources of data used (Table 1) such as the higher use of ABS data by those in strategic (94%) rather than development assessment (48%) roles. Notably high usage of government open data platforms was reported by private sector planners (90%).

Table 1. Groupwise comparisons for data sources used in current role by survey respondents with significant ($p<0.05$) results using Pearson's Chi Squared statistic

Data Source	Group 1	n1	n1%	Group 2	n2	n2 %	Chi Sq	P Val
ABS	DA planning role	12	48.0	Strategic planning role	33	94.3	16.66	0.00
Gov open data platforms	Public sector	25	51.0	Private sector	29	90.6	13.66	0.00
Internal admin databases	Public sector	32	65.3	Private sector	11	34.4	7.44	0.01
Internal admin databases	Local government	28	82.4	State government	4	28.6	12.91	0.00
Internal admin databases	Tech expertise	38	62.3	All other respondents	6	26.1	8.78	0.00
Internal admin databases	GIS expertise	37	67.27	All other respondents	6	26.1	11.12	0.00
Paid or rest. data from public provider	Local government	16	47.1	State government	2	14.3	4.54	0.03
Paid or rest. data from public provider	Data gov expertise	13	52	All other respondents	14	27.5	4.41	0.04
Paid or rest. data from public provider	GIS expertise	23	41.8	All other respondents	4	17.4	4.28	0.04

Software applications used by planners

Responses to questions regarding the use of software show that while use of GIS and online mapping is now widespread across the profession, respondents reported low usage of more novel data and computationally intensive software applications such as machine learning (ML) , artificial intelligence (AI), and virtual and augmented reality (VR and AR) (Figure 4). On the other hand, just under 40% of participants reported utilising social media platforms, indicating a likely increase in the use of these platforms by Australian planners since the 2012 study conducted by Fredericks and Foth (2013). Similar to previous studies (Russo et al. 2018; Russo et al, 2018b) planners continue to report low usage of software for scenario planning and evaluation, commonly referred to in the literature as planning support systems (PSS).

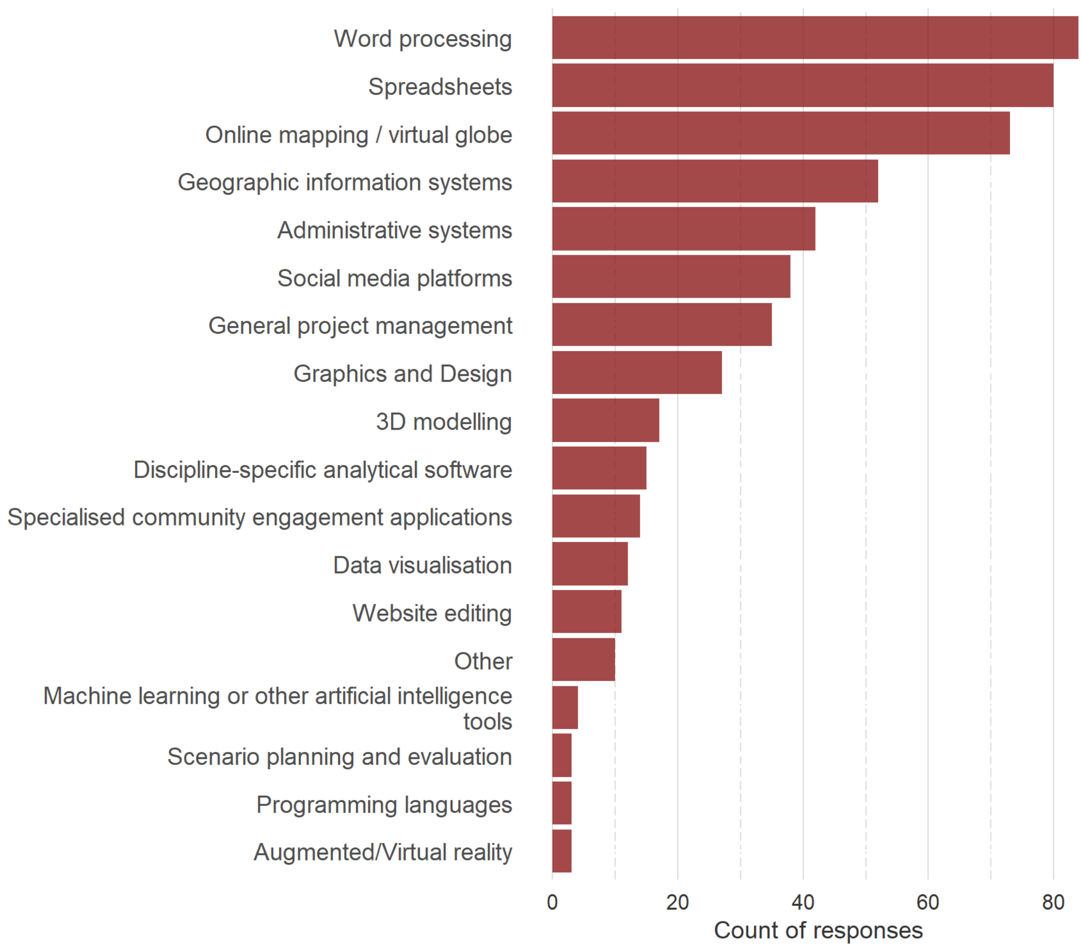

Figure 4. “What type of software applications do you use in your current role?” Horizontal bar chart by count of responses.

Statistically significant results from the comparisons between groups of respondents (Table 2. Groupwise comparisons for data sources used in current role by survey

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respondents with significant (p<0.05) results using Pearson's Chi Squared statistic) again indicate primarily role-based differences, such as the use of administrative systems being more commonly used by public sector planners (59%) compared to private sector planners (31%). These results also indicate that local government planners utilise a more diverse range of specialist or novel software tools when compared to planners in other sectors including online mapping, GIS, 3D modelling and graphics and design software. Interestingly no significant difference was detected between planners of difference experience levels, except for project management software, again likely reflecting a role-based difference with more experienced planners more likely to take on project management duties.

Table 2. Groupwise comparisons for data sources used in current role by survey respondents with significant (p<0.05) results using Pearson's Chi Squared statistic

Data Source	Group 1	n1	n1 %	Group 2	n2	n2 %	Chi Sq	P Val
Administrative systems	Public sector	29	59.2	Private sector	10	31.3	6.05	0.014
Administrative systems	Local Government	24	70.6	State Government	5	35.7	5.04	0.025
General project management	Development Assessment	4	16.0	Strategic planning	16	45.7	5.79	0.016
General project management	< 10 years experience	8	23.5	> 10 years experience	26	54.2	7.70	0.006
Specialised community engagement app.	Development Assessment	1	4.0	Strategic planning	8	22.9	4.07	0.044
Spreadsheets	Public sector	49	100.0	Private Sector	28	87.5	6.44	0.011
Online mapping / virtual globe	Local Government	33	97.1	State Government	10	71.4	6.98	0.008
Geographic information systems	Public sector	35	71.4	Private Sector	15	46.9	4.94	0.026
Geographic information systems	Local Government	32	94.1	State Government	3	21.4	26.53	0.000
Geographic information systems	Tech expertise	45	73.8	All other respondents	7	30.4	13.30	0.000
3D modelling	Local Government	9	26.5	State Government	0	0.0	4.56	0.033
3D modelling	Tech expertise	17	27.9	All other respondents	0	0.0	8.04	0.005

Graphics and design	Local Government	14	41.2	State Government	0	0.0	8.14	0.004
Graphics and design	Tech expertise	25	41.0	All other respondents	2	8.7	7.98	0.005

Anticipated changes to planning work

Despite results indicating that use of novel data and computationally intensive technologies is relatively low amongst professional planners, when asked in an open-ended question to describe anticipated changes to their work in the next ten years, these technologies feature prominently in respondent's answers. Anticipated changes were applicable across broad range of planning and professional tasks, with the thematic analysis uncovering three overarching themes in respondent answers (Figure 5):

- **Data Driven Future**: New sources of data and improved means to access existing data will offer new and real-time insights into how the city is changing and growing, including development patterns, demographic trends and transport information. New technology will include software tools that automate complicated data processing tasks and enable planners to undertake work previously requiring specialist expertise.
- **Communicative Future:** Improvements to technology offers new and faster ways for all parties in the planning process to communicate, whether through social media, online video conferencing or other bespoke community consultation applications. Digital technology will also offer new ways to present planning information to make the planning process accessible to more participants, whether the community or other professionals in adjacent industries. Anticipated changes include more visual representations of change

through interactive maps and three-dimensional modelling, and automated personalised planning advice enabled by digital representation of planning regulations.

- **Administratively Efficient Future:** Administrative burdens are reduced as digital technology automates large swathes of bureaucratic processes including data entry, report writing and many aspects of development assessment, enabled by improved digital representation of planning regulations. This would free up time of planners to focus more on higher level planning tasks such as strategic planning.

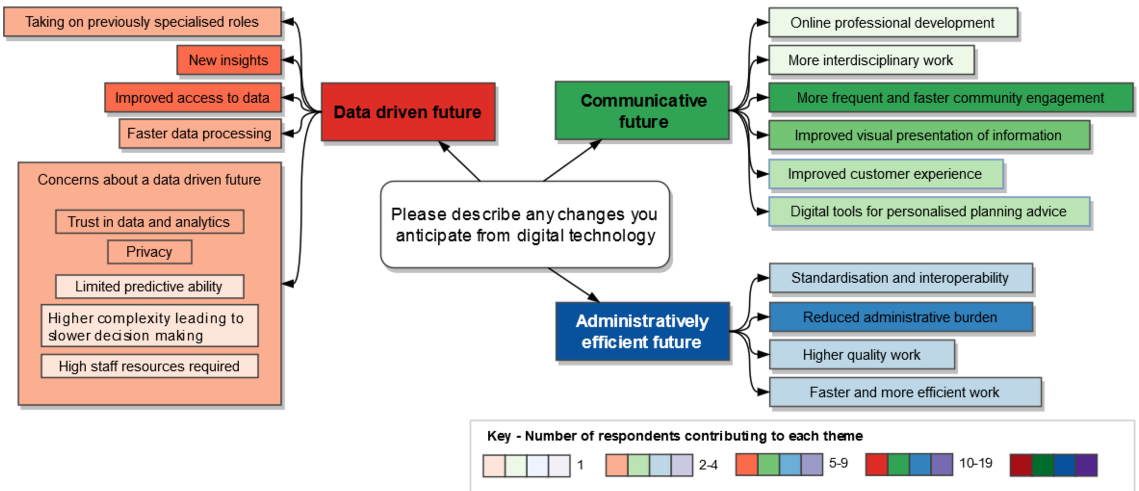

Figure 5. “Please describe any changes you anticipate from digital technology” themes identified through inductive thematic coding analysis of open text responses.

Important to note that several respondents included within their response an outline of concerns alongside descriptions of anticipated data-driven changes, particularly centred around privacy and the ability to trust data sources and associated analytics.

Survey – Barriers to the adoption of new technology

Although a large degree of change is anticipated arising from new technological capabilities, a wide range of institutional and individual barriers to the adoption of new technology were also identified in the thematic analysis of responses to an open question. These responses can be characterised under four overarching themes (Figure 6):

- **Uncertainty in adopting new technology:** Adoption of new technology is accompanied by uncertainty as to whether the benefits will outweigh the costs involved, and how long it will be before a given technology becomes redundant. Respondents indicated that assessing these risks is particularly difficult given their own limited technical expertise.
- **Poor quality technology:** Many respondents described poor experiences with technology that was difficult to use, not fit for purpose or did not integrate with existing systems.
- **Cost and resources:** Cost was the barrier most frequently described and includes both the cost of new hardware and software licences, and the time required to train staff or additional payment for specialised staff.
- **Change resistance:** Many respondents described a general cultural inertia when it comes to the adoption of new technology. Some of responses identified this inertia stemming from both institutional arrangements, such as existing regulatory requirements, a lack of leadership interest and individual reluctance to learn new ways of doing things.

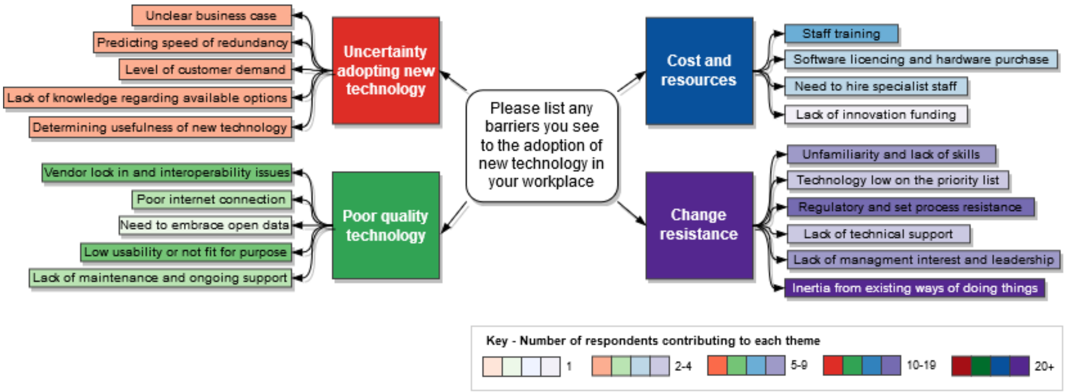

Figure 6. “Please list any barriers you see to the adoption of new technology in your workplace” themes identified through inductive thematic coding analysis of open text responses.

Scale and preparedness for change

Most respondents are anticipating a high degree of change (modal score = 4), but rate themselves lower when it comes to being prepared for this change (modal score = 3). Likewise, respondents also gave a lower rating for how easy they felt it was to implement new technology in the workplace (modal score =3).

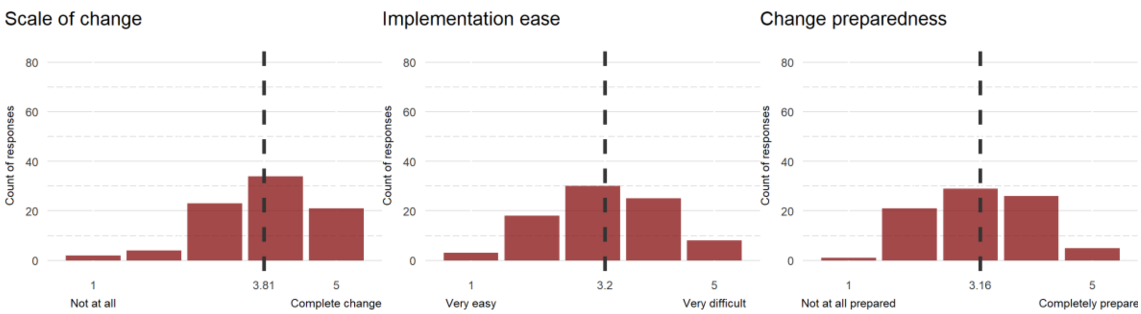

Figure 7. “How much do you think digital technology will change the work you do in your current role within the next 10 years? How easy is it to implement new digital technology in your workplace? How easy is it to implement new digital technology in your workplace? Histograms showing distribution of responses, mean value indicated by dashed line.

Pairwise comparisons between groups for each of these questions revealed few significant differences with the exception of respondents with programming experience predicting a higher degree of change, and strategic planners indicating greater difficulty in the implementation of new technology (Table 3).

Table 3. Groupwise comparisons for change scores recorded by survey respondents with significant ($p<0.05$) results using Wilcoxon Rank Sum statistic

Question	Group 1	n1	Mean	Med	Group 2	n2	Mean	Med	Wilcox	P Val	R
Scale of change	Programming experience	11	4.636	5	All other respondents	63	3.778	4	149.5	0.001	-0.37
Implementation ease	Strategic planning	35	3.429	3	DA planners	25	2.72	3	275.5	0.012	-0.33

Pathways for dissemination of new technology

Respondents were asked to report on the source they used to find out about the latest developments in planning, a key indicator to understand diffusion pathways for the adoption of technological innovations (Rogers 2003) and also for targeting professional development programs. Results indicate that the workplace remains the primary place for professional planners to learn about new developments followed by web searches. Other traditional media such as industry reports, conferences, and workshops and seminars scored relatively highly relative to many newer sources such as social media platforms.

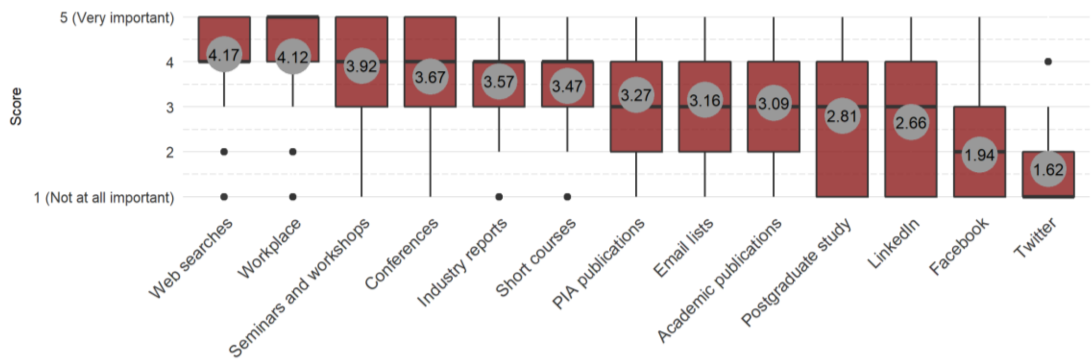

Figure 8. “Based on your personal usage, on a scale from 1 to 5 how important are the following sources for you to keep up with the latest development in planning?” Box and whisker plots with mean values labelled.

Pairwise comparisons between groups of respondents reveal fewer role-based differences, although those with software programming expertise indicate the workplace is less likely to be their primary provider of professional development.

Table 4. Groupwise comparisons for information source usage scores recorded by survey respondents with significant ($p<0.05$) results using Wilcoxon Rank Sum statistic

Data Source	Group 1	n1	Mean	Med	Group 2	n2	Mean	Med	Wilcox	P Val	R
Linkedin	Public sector	46	2.457	2	Private sector	31	3.097	3	508.0	0.029	-0.25
PIA Publications	Public sector	48	3.021	3	Private sector	32	3.688	4	536.0	0.020	-0.26
Facebook	> 10 years experience	43	1.605	1	< 10 years experience	33	2.394	3	960.0	0.005	-0.32
Academic publications	Tech expertise	59	3.271	3	All other respondents	22	2.591	3	465.5	0.045	-0.22
Academic publications	Data governance expertise	25	3.6	4	All other respondents	50	2.78	3	375.0	0.004	-0.33
Facebook	GIS expertise	51	2.196	2	All other respondents	23	1.522	1	386.0	0.013	-0.29
Workplace	Programming expertise	11	3.545	4	All other respondents	60	4.3	5	451.0	0.032	-0.25
Workplace	Tech procurement expertise	18	4.778	5	All other respondents	52	4	5	319.0	0.025	-0.27

The frequency with which respondents engaged with this material showed a relatively even distribution from those who engage a few times a week (n=18) to those engaging less than once a month (n=24).

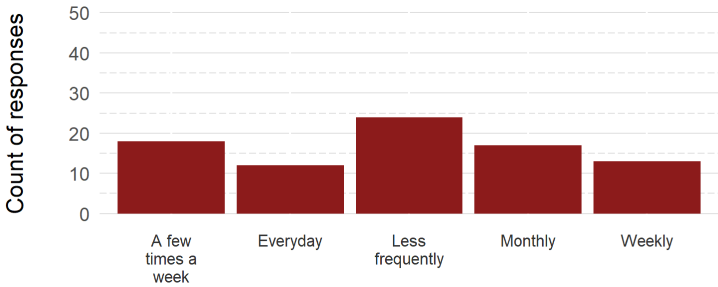

Figure 9. How often do you engage with external content about the latest developments in digital technology and planning? Vertical bar chart by count of responses.

Workshop

Supplementary to the survey results, material created at the workshop enabled deeper exploration of how digital technology is anticipated to change planning work in context of specific tasks and scenarios self-identified by participants, as commonly undertaken in their day to day work as professional planners.

Planning Project Workflow Mapping

Each of the three groups was asked to map out the workflow of a typical project undertaken by participants. The following were chosen and a complete copy of the workflow as recorded by each group of participants is attached in the supplementary material:

- **Group 1:** Preparation of a "Statement of Environmental Effects" (SEE) report, the primary document prepared with the lodgement of a development application in the state of NSW, outlining the scope of the development and its compliance with the relevant planning policies and legislation. This report is typically prepared by specialist planning consultants.

- **Group 2:** Preparation and assessment of a development application.
- **Group 3:** Undertaking the preparation of a master plan for a large development. A master plan is a document typically required when a proposed development encompasses a large area and outlines the layout of various land uses and required accompanying infrastructure.

Having reached a consensus very quickly on a standard project workflow, participants were asked to identify specific problems or "pain points" they commonly experienced undertaking this work. The thematic analysis of the group responses is summarised in Figure 10. Problems and pain-points identified by workshop participants when undertaking standard planning projects. Themes identified through inductive thematic coding analysis of open text responses..

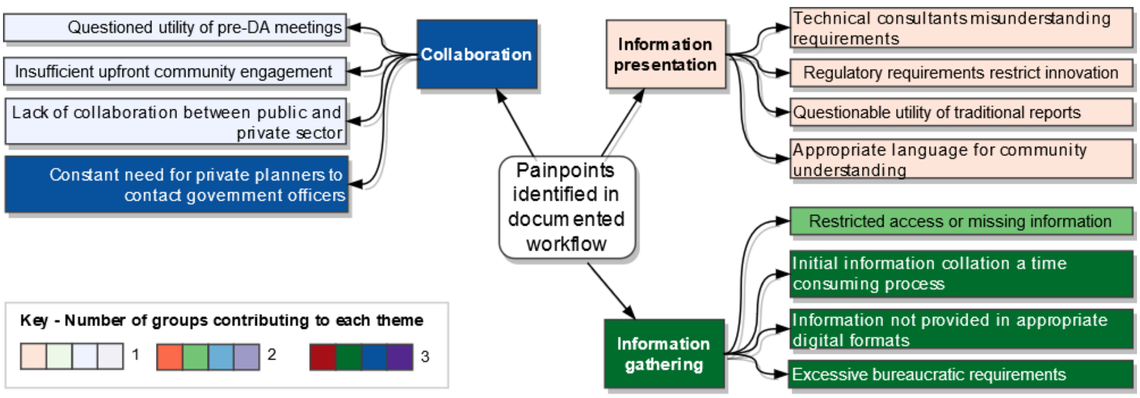

Figure 10. Problems and pain-points identified by workshop participants when undertaking standard planning projects. Themes identified through inductive thematic coding analysis of open text responses.

Although focused on different aspects of the planning process common frustrations were identified. Basic information retrieval was found to be a time-consuming process in each group's workflow, although necessarily required for due-diligence and background studies. In addition, each group identified frustrations with the lack of communication between private and public sector planners, with private sector planners constantly feeling the need to "chase up" government officers for application updates.

Imagined technology solutions

Finally, each group was asked to imagine their own technology solution to improve the outcomes of a specific task.

- **Group 1** – Replace the current development application report document (known locally as the "State of Environmental Effects") with an interactive online platform describing the development proposal with an intuitive interface to allow for exploration at the desired level of detail. The platform would be capable of three-dimensional visualisation and exploration of the proposed development. The platform would also be capable of automated compliance assessment and visually indicate with red-flags areas of non-compliance with relevant planning policy and regulation. The platform would also allow for annotations to be added by members of the community, government officers and the developer to allow for collaborative identification of problems and solutions.
- **Group 2** – A new interactive online platform integrated with government systems to communicate information to prospective applicants and the community prior to the lodgement of a development application with the aim of

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improving the quality of the application, reduce double handling of relevant information and to simplify assessment. The platform would provide personalised planning advice for any given parcel of land which would: map site constraints and attributes, show past approvals within the area, three-dimensional modelling enabling identification of permitted building envelopes, upload and integration of architectural plans and a pre-assessment of quantifiable building controls, and outline submission requirements clearly including required application fees and development contribution taxes.

- **Group 3** – A interactive online platform linked to a centralised repository for government data, allowing smoother management of access to restricted datasets. Desired features include spatial search and request functions with the ability to draw self-defined geographic boundaries, standard guidelines for format, a market place of tools, simplified access and licencing arrangements, feedback loop to ensure improvements can be made based on customer feedback, and ability to track data request applications. Participants identified that this approach would need to be accompanied by cultural change and resources to build this capacity into all government agencies.

Discussion

In an era of high expectations around big data and smart cities technologies, the results of this survey show that use of these more novel urban data sources (such as IoT data) and computationally intensive technologies (such as AI and machine learning) in professional practice continues to be low, in line with the findings of previous studies. Of note for Australia open data initiatives, whilst most respondents reported utilising government open data portals very few respondents (n=2) reported using the portal provided by the Australian Urban Research Infrastructure Network (AURIN) (Sinnott et al. 2015), a portal that provides access to over 5,000 datasets and a suite of analytical tools (C. Pettit, Tanton, and Hunter 2017; C. Pettit, Tice, and Randolph 2017; Bishop et al. 2017; Badland et al. 2013) . These findings come despite the large amount of research published in recent years involving the design and test if new digital platforms and tools. Interestingly, the results from our study were relatively homogenous across planners with different levels of experience, indicating that even if younger planners are more familiar with the use of technology, that they may not be being provided with opportunities to apply these skills to their work as professional planners.

The solutions derived by workshop participants may provide some additional insight into the relatively low use of newer digital technologies. When asked to design a system to assist with their day-to-day work, participants focused on improving basic data-retrieval and improving the efficiency of existing systems. Furthermore, the lack of this fundamental digital infrastructure is considered an inherent problem when considering the possible adoption of eplanning tools, let alone more complex, data and computationally intensive software technologies such as those typically addressed by the PSS literature. This observation is supported by the findings of a recent report into spatial data availability for metropolitan planning in Australia by Duhr, Gilbert, and Peters (2020) which highlights that although needed datasets exist, they are not necessarily in the right format to be of use at scale.

Whilst it may be said that professional planners are unaware of or untrained in the use of more computationally intensive technologies, such as those PSS designed to assist with urban modelling supported scenario planning (for example UrbanSim

(Waddell 2002) and What if? (C. Pettit et al. 2020)), these findings also highlight the relatively minimal attention paid by digital planning scholars to the administrative and bureaucratic functions that occupy much of the of day to day work of professional planners. These functions, such as automated planning guidance and faster approvals are prominent themes emerging from the participants of this study, and the focus the recent initiatives by various digital service teams within government. It is through these initiatives that much of the pre-requisite digital infrastructure and data collection processes are likely to be constructed. Further research in this area is needed in order to evaluate whether these initiatives are fit for purpose in order to facilitate the implementation of more advanced or specialised technologies at scale to improve both the efficiency of the planning system, and more importantly achieving place-making outcomes of making our cities more liveable, sustainable and resilient.

Unlike previous studies, this research was conducted independently of the consideration of any specific type of data platform, technology or software tool. This distinction has proved worthwhile as results have been able to identify a more systemic range of barriers and considerations to the adoption of technology in planning practice than purely data availability issues as discussed above, and the technical usability matters traditionally considered in the PSS literature (Vonk, Geertman, and Schot 2005; Vonk and Geertman 2008; Vonk and Ligtenberg 2010; Russo et al. 2015, Pelzer et al. 2015). Many additional cost and risk-based considerations apply in the decision to adopt new technology in professional practice, aligned to the findings of more generic studies into the adoption of technology in government. The results of this study are notably comparable to Shaikh and Cornford (2012) who mirror three of the barriers identified in the survey results as described above, with the categorisation of their results under "risk management", "technical and development issues" and "economic factors". These results indicate that the benefits of a given technology will need to be well established (e.g. through a successful pilot or other case study) before widespread adoption will occur.

An additional category of constraints to the Shaikh and Cornford (2012) study was developed to characterise the results of this study called "change resistance". This category captures themes around cultural inertia, including respondent's concerns around regulatory requirements in planning that may preclude the adoption of new technology or more effective practices. Observations from the workshop also provide evidence for strong cultural inertia. Despite the participants within each group representing a range of different planning organisations and workplaces, it was notable how quickly consensus was achieved during this exercise, as confirmed by workshop facilitators in the closing recorded discussion. It is also notable how closely the recorded workflows resemble similar stepped-process theories of planning and policy making, including rational-process based models of planning and the policy cycle (Taylor 1998; Althaus, Bridgman, and Davis 2018). These findings suggest that the profession operates using established processes which, even where not mandated by law, may also be a barrier to more widespread and systematic innovation. Despite these concerns however, results indicate that significant change is anticipated by professional planners, and to some extent welcomed – many expressing frustrations with the software and processes they currently use.

Although the approach taken allowed the identification of the priorities of practicing planners, it is recognised that insights are limited to the extent that practicing planners tend to operate within existing systems, a factor likely to shape the imagination of responses when asked questions about digital transformative potential. This study would be complimented by additional work to repeat the exercise as relevant to other key stakeholders in the planning process, especially members of the general community who are generally overlooked in such studies. It is also acknowledged that this research was undertaken in the months before the global COVID-19 pandemic occurred. Since this time many planning organisations have been forced to rapidly adopt technology, including online communication platforms, to allow the continuation of planning processes undertaken through remote working arrangements. A follow up study is recommended to measure the degree to which changes may have occurred.

Conclusion

Significant and far-reaching changes to day to day work are anticipated by practicing planners in the face of rapid technological change. New sources of data and greater computing power are expected to generate faster insights into how cities are changing and growing. Online platforms are expected to enable improved communication and engagement in planning processes including instant feedback, the ability to visualise proposals in three dimensions, and to simplify and filter information according to the needs of the user, whether a local resident or specialist consultant. Alongside these new opportunities, widespread automation is also expected in many day to day administrative tasks currently performed by planners, especially in relation to development assessment.

Nevertheless, even if digital tools provide the means to facilitate radically more transparent, participatory and effective forms of planning, empirical studies into digital government suggest that historically the implementation of new technology tends to reinforce existing hierarchies and processes (Lips 2020; Kraemer and King 2003). Currently research into the development of digital planning tools and methods tends to take a technologically deterministic approach, with the underlying assumption that if the tool or method is proved to be superior, the planning processes will change to follow suit. The results of this study however suggest that there remains a large implementation gap, the reasons for which extend beyond simple considerations of the technical usability of new technologies. Whilst evidence suggests state and national governments are moving to reverse some of the outsourcing effects of NPM through the establishment of dedicated digital services teams (Mergel 2019; Evans et al. 2019), questions remain around the institutional arrangements that will allow hundreds of local authorities the resources to achieve the similar levels of innovation. Deeper leadership, cultural and institutional changes are necessary if digital technology is to facilitate achievement the normative goals of more transparent, participatory and effective planning. As various governments continue to implement their digital transformation agendas, it is important that all key stakeholders groups including practicing planners, academia, and the community are involved in order to ensure that new technology can assist in better planning, and the achievement of equitable and sustainable future outcomes.

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Supplementary material – Survey Questions

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General Questions

1) Multiple selection: What sources of data do you use in your current role? (select all that apply)

- Australian Bureau of Statistics (e.g. Census data)
- Social media (e.g. Twitter, Facebook)
- Government open data platforms (e.g. data.nsw.gov.au)
- Commercial data provider (e.g. CoreLogic, Google)
- Paid or restricted data from a public provider (e.g. Public Sector Mapping Agency, ASIC)
- Internal administrative databases (e.g. property and asset registers)
- Local Development Performance Monitoring
- Australian Urban Research Infrastructure Network (AURIN) Portal
- IoT data
- Other (please list):

2) Multiple selection: What type of software applications do you use in your current role? (select all that apply)

- Word Processing (e.g. Microsoft word)
- Spreadsheets (e.g. Microsoft Excel)
- Website editing (e.g. WordPress, Drupal, HTML)
- Social media platforms (Twitter, Facebook, LinkedIn)
- Specialised community engagement applications (e.g. Consultation manager, Engagement HQ)
- General project management (e.g. Microsoft Project, Trello)
- Administrative systems (e.g. Development assessment platforms, asset management)
- Geographic information systems (e.g. ArcGIS, QGIS)
- Data visualisation (e.g. Tableau/Power BI)
- Graphics and design (e.g. Adobe creative suite)
- 3D modelling (e.g. ESRI CityEngine, Revit, SketchUp)
- Online mapping / virtual globe (e.g. Google Earth, Street View, Nearmap)
- Augmented reality/virtual reality (e.g. Unreal Engine, Unity)
- Programming languages (e.g. Python, R)
- Scenario planning and evaluation (e.g. UrbanSim, Raise, What if?)
- Discipline-specific analytical software (e.g. flood modelling, transport modelling)
- Machine learning or other artificial intelligence tools
- Other (please describe):

3) Scale: Based on your personal usage, rate how important the following sources are for you to keep up with the latest developments in planning.

- 1 (not at important) → 5 (very important)
  - My workplace
  - LinkedIn
  - Twitter
  - Facebook
  - Web searches

o PIA Newsletters and magazines
o E-mail lists
o Seminars and workshops
o Conferences
o Short courses
o Postgraduate university study
o Industry reports
o Academic publications
o Please list any other sources:

4) Multiple choice: How often do you engage with external content about the latest developments in digital technology and planning?
• Everyday | a few times a week | weekly | monthly | less frequently

5) Scale: On a scale from 1 to 5 how much do you think digital technology will change the work you do in your current role within the next 10 years?
• 1 (no change) → 5 (complete change)

6) Open: Please describe any changes you see from digital technology:

7) Scale: On a scale from 1 to 5 how easy is it to implement new digital technology in your workplace?
• 1 (very easy) → 5 (impossible)

8) Open: Please list any barriers you see to the adoption of new digital technology in your workplace.

9) Scale: On a scale from 1 to 5 how well do you feel prepared for this change?
• 1 (not at all prepared) → 5 (completely prepared)

10) Open: Do you have any comments to add around opportunities and barriers for adopting new digital technology in the wider planning profession (outside your current role)?

11) Scale: How important do you rate each of the role/s of PIA could play to support planners through digital change?
• 1 (not at important) → 5 (very important)
o Professional development – ensuring all planners are equipped with the right skills and education to use and shape technology in their roles
o Advocacy – advocating for the adoption of various digital technologies and standards in planning processes.
o Leadership – facilitating a conversation about the role of technology in the planning profession
o Communication – communicating to members advances in technology that apply to the planning profession

12) Open: Are there any specific initiatives you would like to see PIA undertake?

13) Open: Do you have any general comments you would like to add on the impact of digital technology on planning work?

Demographic Questions

1) Multiple choice: What type of institution do you currently work for?
• Local Government
• State Government

- Federal Government
- Private Sector
- Academia
- Other (please describe)

2) Multiple choice: Where are you based?

- NSW | Vic | QLD | WA | SA | Tas | ACT | NT | Overseas

3) Multiple choice: How many years of professional planning experience do you have?

- 0 (studying) | 1 to 5 | 5 to 10 | 10 to 20 | 20+

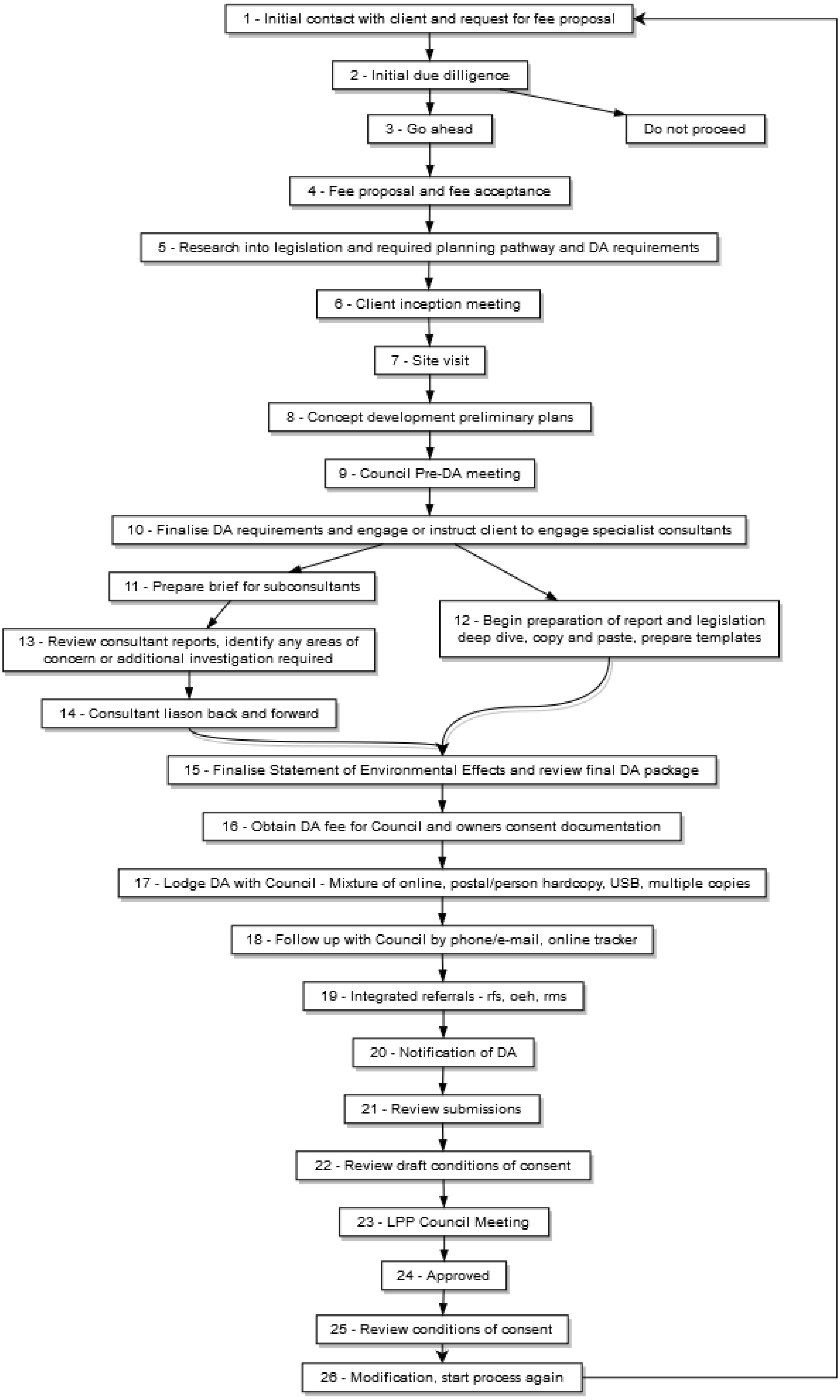
4) Yes/No: Do you have experience in data governance?
5) Yes/No: Do you have experience in using GIS?
6) Yes/No: Do you have experience in computer programming?
7) Yes/No: Do you have experience in technology procurement?
8) Multiple selection: What category/categories best describes your current role?

- Development assessment
- Strategic planning
- Environmental planning
- Transport planning
- Economic development
- Infrastructure planning
- Urban design
- Other (please describe)

9) Yes/No: Are you currently a PIA member?

Supplementary material - workflows

Pre-print version of amended manuscript by C. Daniel and C. Pettit after reviewer feedback. The Version of Record of this manuscript has been published and is available in Australian Planner - 5 May 2021 - https://www.tandfonline.com/doi/abs/10.1080/07293682.2021.1920995.



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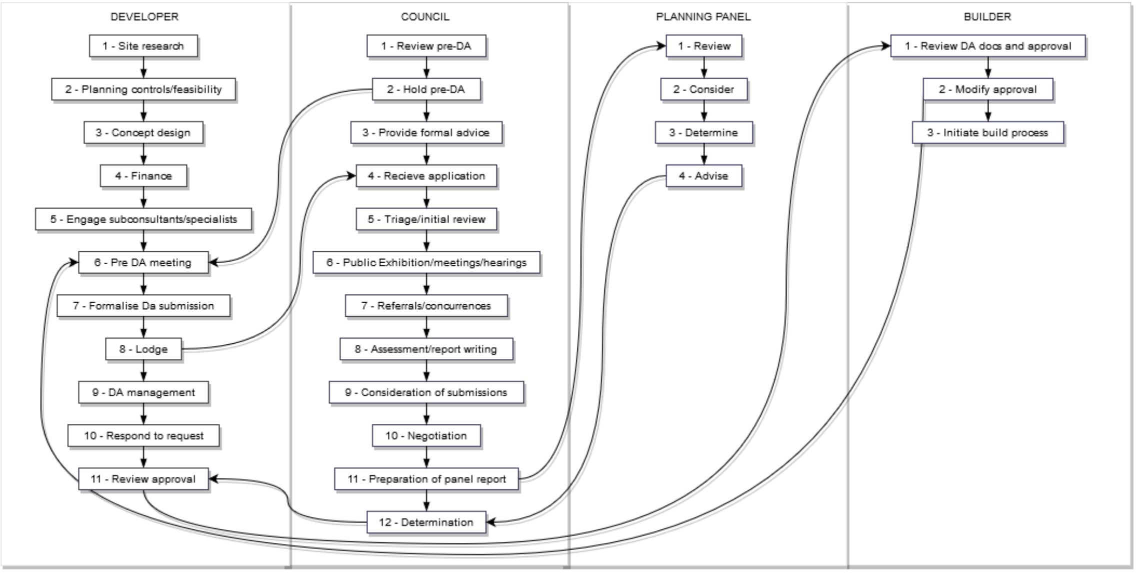
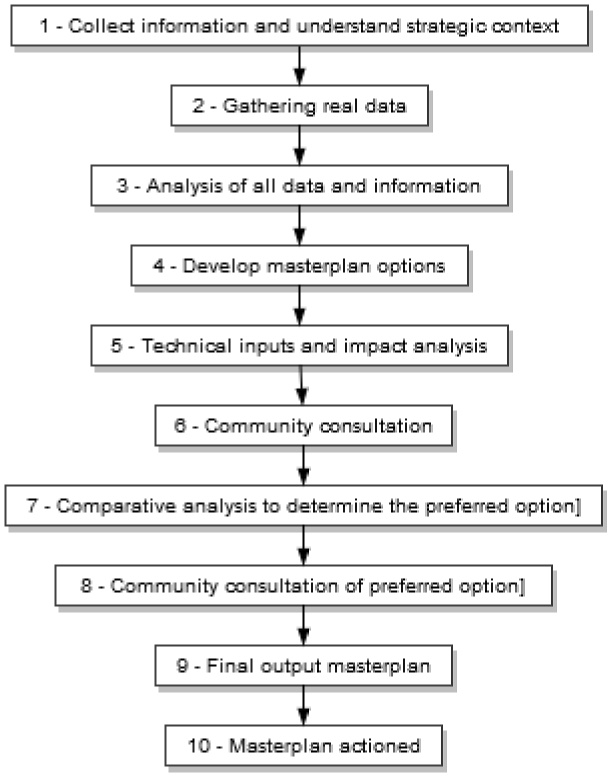
Group 1 - Workflow for preparation of the “Statement of Environmental Effects” planning report.



Group 2 – Workflow for the preparation and assessment of a development application



Group 3 - Workflow for preparation of a master plan