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How is Mobile Technology Changing City Planning? Developing a Taxonomy for the Future

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ABSTRACT

The emergence of web technology has created tremendous opportunities for improving the role of good government, specifically in the form of increased information, interaction with the public, and more cost effective and efficient means of conducting public business transactions. These opportunities have been broadened with the introduction of internet-enabled mobile devices, as location-based information is used to increase awareness of user activity, movements and behaviors in real-time conditions and specific contexts (Kwak, Lee, Park & Moon, 2010). Some argue that the transition to mobile changes the nature of work and can allow individuals to work outside the office and create knowledge creation that is geographically referenced (Zurita, 2012).

Based on a survey of public sector planning officials, this study confirms other work that suggests high levels of smartphone use for work purposes (Evans-Cowley & Kubinski, 2013), there are still locations where local planners do not have desktop computer access and there is little reliance on web technologies. That said, despite high levels of mobile use, activities conducted via mobile continue to be less transactive than the literature suggests, leaving room for future growth as mobile phones and tablets increase in prevalence.

While some have argued that e-government tools have two major roles, 1) information sharing and 2) receptive exchanges (Evans-Cowley, 2010; Evans-Cowley & Kitchen, 2011). We argue that there is a third role for planning and e-government technology – the interactive or transactive. Given this framework, this research establishes a taxonomy for how the utility of mobile technology, defining how it can be used to change planning and local governance.

Keywords: planning; local government; mobile; technology; transactive

Words: 8300

INTRODUCTION

Advances in mobile technologies have begun to fundamentally change the way city planning professionals and those in local government understand and interact with their local communities. These technologies have the potential to alter the way planners develop and sustain their local communities in a more efficient and productive manner. Due to the rapidly advancing mobile technology market, many planners have not had the resources or time to adopt many of the technologies that are available to them. This paper explores (1) how mobile technology is currently influencing planning practices, (2) defines a taxonomy for current mobile applications, and (3) hypothesizes how these technologies will influence the future of the planning profession.

BACKGROUND

Citizens have historically interacted with local government agencies off-line but due to technological advances over the past years, many such activities are now reliant on computers. As the cost of those technologies have significantly decreased, planning agencies have been able to incorporate various forms of technology into their practice to both increase their engagement with the public and obtain a better understanding of the patterns of activities that occur throughout the urban fabric within which they work. In a book entitled, *E-topia* (1999), William Mitchell states that "In the twenty-first century, then, we can ground the condition of civilized urbanity less upon the accumulation of things and more upon the flow of information, less upon geographic centrality and more upon electronic connectivity, less upon expanding consumption of scarce resources and more upon intelligent management" (p. 155).

As cities grow, it is important for the advancement of their communication networks to grow in a corresponding manner in order to effectively and efficiently disseminate information across a larger distance or throughout a larger population. Often times, "policy matters are still handled by people who are not sufficiently aware of the implications of technological trends. In addition to that, most of them base the planning of future developments on the premise of demoded theories, devoid of stringent forecasting potentials" (Alshuwaikhat & Nkwenti, 2003, p. 295). Especially in areas of rapid growth, such as in developing countries, it is difficult for government administrations to deal with increased population densities and services infrastructures, and the implementation of advanced communication technologies are beyond the scope of maintaining basic services for their residents. However, the absence of such technologies "makes it even more difficult for them to see associated problems, thoughtless of providing meaningful policies to regulate their deployment" (Alshuwaikhat & Nkwenti, 2003, p. 296).

In "A Historical Perspective of Technology and Planning," Pitkin (2001), explains that this "technological lag" was the result of "a dominant 'technocratic ideology' that stunts the historical memory of planners and forces them to place unfounded faith in technological fixes. In the late 19th century, there was a paradigm shift which ultimately "persuaded people to put their faith in technology, rather than in people" (p. 36). The use of computers by planning agencies has perpetuated this technocratic ideology, as "expert planners" were called upon to optimize various aspects of planning with computer modeling and simulation (Harris, 1996). Pitkin continues to argue: "planners have largely exemplified technocratic ways of thinking by looking to technological innovations to solve urban problems without considering its possible limitations and unintended consequences (p. 41).

The advent of the microcomputer during the 1970s drastically changed the impact that computers had on the urban planning profession, as the technology was more widely accessible, a greater number of planners were able to take advantage of computing in order to increase their efficiency and productivity. Although computers allowed for reduced costs for administrative support, service planning and information processing (Pitkin, p. 47) there were many problems associated with the new technology, including limited staff time and unanticipated technological costs. Many planners "began to appreciate that computers would be useful in their work only in as far as they were part of a social process that used the computer for what it was, a tool," and not as a substitute for decision making on the part of the planner (Pitkin, p. 47).

Beginning in the 1980s, a move away towards scientific (or technocratic) planning towards more communicative processes had a great impact on the use of technology for urban planning. Advances made in communicative information technologies—including the development of new computers, software and databases—allowed for new and innovative forms of citizen participation in urban planning. This new paradigm of social participation in planning led to the development of collaboration software which allows both citizens and planners to provide and receive information (Hanzl, 2007). Technologies such as discussion forums, social networking sites, document collaboration, and online polls/crowdsourcing have all helped planners engage with citizens to support the decision-making process (Evans-Cowley, 2011). These interactive technologies not only help to inform citizens with up-to-date information about planning processes, but also ensure that open dialogue and constant two-way communication is part of those planning processes.

Many of these participatory and interactive technologies have allowed for some form of virtual simulation or Augmented Reality (AR) systems into the urban planning process. In fact, most plans, perspective drawings, and scale models are simulations in one way or another, although most people do not perceive them in that way (Zube and Simcox, 1993). Kaiser and Godschalk (1995) argue that land use plans are "more likely to be drafted, communicated, and debated through electronic networks and virtual reality images," (p. 382). Since the representation of urban space in citizens' minds plays an important role in the alteration of real space (Hanzl, 2007), virtual reality systems and simulation can help planners better understand citizens' image of the city. Decker (1993) explains how a simulation serves as "an accessible surrogate for the city's complex systems, extensive spatial structure, or environmental influences."

Simpson (2001) examines the extensive literature that addresses virtual reality and urban simulation in planning practices, and demonstrates the potential for virtual simulations to make complex alternative scenarios more clear and accessible allows for increased potential citizen participation and a more satisfactory planning process. Gordon & Koo (2008) describe a pilot program in Boston, Massachusetts called Hub2, which utilized the virtual world Second Life to engage citizens in participatory activities. These virtual platforms facilitate a sharing of experiences in a controlled environment (which they define as a multi-user virtual environment), and empower citizens to express their own visions of public and civic space in order to form politically powerful groups.

One widely used planning technology which has been increasing its level of interactivity is Geographic Information Systems (GIS), or geo-relational databases. GIS are tabular data sets that relate to various geometric objects that represent real world objects. These systems are often used in urban planning to gather, store, analyze and represent geo-relational data (Hanzl, 2007). The advent of Geographic Information Systems created a fundamental shift in the field of urban planning, and as the use of GIS technology spreads in society, it is becoming available to an increasingly large number of non-experts (Lindholm, 1992). GIS have begun to evolve into various forms of Participatory GIS, or Community-integrated GIS, whereby data is stored on the Internet (instead of software), and can be manipulated in any way the user wishes the data to be presented (Hanzl, 2007).

Dunn (2007) argues: "these new approaches are context- and issue-driven rather than technology-led, and seek to emphasize community involvement in the production and/or use of geographical information" (p. 616). This is what Goodchild (2011) constitutes a "fundamental paradigm shift in GIS, from the old model of an intelligent assistant serving the needs of a single user seated at a desk, to a new mode in which GIS act as media for communicating and sharing knowledge about the planet's surface with and among these masses," (p. 1738). Over the last few years, GIS technology has shifted from being a technocratic technology to a popular social medium for citizens to report various problems and build community. Forth, et al., (2009) define this paradigm shift as the introduction of "NeoGeography," whereby tools and services allow non-geographers to utilize GIS for their purposes.

Many of these activities are now being completed online. A report entitled "E-government" released by the American Planning Association, describes a variety of e-government tools and capacities that local government agencies utilize to interact with citizens, and organizes such tools into two main categories: 1) tools for information sharing—such as websites, mapping, and scenario planning; and 2) tools for interaction—such as social networking sites, crowdsourcing, and mobile applications (Evans-Cowley & Kitchen, 2011). The report defines informational tools as technological tools that provide the public with news, data, plans ordinances, and other relevant planning information. Interactive technological tools rely on interaction between the planning agency and the public. This study attempts to build off the definitions provided by the "E-Government" report, and organizes the various interactions in the following three ways receptive, interactive and transactive.

Receptive interactions involve a one-way transaction of information from the government agency to the citizen, or vice versa. Citizens typically want to know things like: What are the applicable zoning ordinances for my property? What is the plan for growth in my community? When are public hearings scheduled? How do I file for a permit/variance? On the other hand, planning agencies typically want to understand basic demographic characteristics of a certain Census tract, or understand dimensional characteristics of parcels. These information seeking activities have frequently been translated to online platforms, where one can simply look up the information online.

Interactive tools rely on some sort of interaction between the planning agency and the public. "Off-line" interactive exchanges involve a two-way transaction of information between the local agency and the public, as citizens often want to share their thoughts regarding how things are being done in the community and what is planned in the future. Prior to web technology the citizen had limited choices- they could attend a public hearing/meeting, they could visit the planning office in person, they could call the planning office/city manager, or write a letter.

The web has provided additional options that make interactivity more accessible: Citizens can download permit application forms; they can review plan proposals on line and then comment on them. In some cases there are on-line forums and chat rooms that are open to residents to discuss issues before the community. The new 24-hour availability of these functions makes government more accessible to more people and offers additional communication channels that are intended to improve information availability and better decision-making.

Finally transactive tools involve an exchange between agencies and citizens. Many of these activities would have previously required a citizen to visit the local government offices, can now be conducted on-line. Some examples from planning are the purchase of copies of the Comprehensive Plan or Zoning Codes, the filing of permits, variances and appeals, and the paying of associated fees for permit and other applications. The introduction of e-Business adds a "transactive" quality to planning web sites, that allows more efficient and cost-effective transaction by automating the payment and order process.

Transition to Mobile

In recent years the proliferation and transition from desktop to handheld computers, or mobile phones has been dramatic. According to a report released in 2012 by the CTIA-The Wireless Association, there are currently over 320 million wireless subscriber connections (active devices associated with subscriptions or prepaid accounts), with over 150 million of those being smartphone connections (CTIA, 2012). As mobile devices have become increasingly pervasive in urban life, various studies have been conducted which demonstrate how mobile technology has begun to alter various human behaviors and interactions in an urban setting. These technologies not only influence the way people move throughout their communities and interact with one another, but will influence the way urban planners and city officials understand and interact with their citizens.

Katz (1996, 1998) argues that the mobile phone has rapidly evolved into an object with which people have developed a personal relationship, and mobile phones have been noted as a symbol of aggressive individualism (Harkin, 2003). The use of a mobile phone has been viewed as an isolating activity, in which people can create a personal "bubble" around them when talking on the phone (Gergen, 2000; Bassett, 2005; Hall, 1966). Many people have experienced this phenomenon when entering a crowded subway or bus, and everyone is staring down at their mobile device and not paying much attention to their surrounding environments.

On the other hand, some theorists have noted how mobile technology and other information community technologies (ICTs) can in fact "facilitate community participation and collective action by creating large, dense networks of relatively weak social ties and as an organizing tool," thus strengthening formerly weak social connections. (Hampton, 2003). According to a Pew Internet Poll done in 2013, 72% of Internet users stated that they use social networking sites, including 40% of cell phone owners. Internet-enabled mobile devices incorporating GPS has allowed for location-based SNS and social networking content, which could then be used to increase awareness of user activity, movements, and behaviors in real-time conditions and specific contexts (Kwak, et al., 2010). This location-based SNS data can also be extremely useful for urban planners in that it can be analyzed to make assumptions about citizens' behavioral patterns and preferences in urban environments.

Real-time conditions create a more legible urban landscape for the citizen, thus creating more efficient and sustainable mobility patterns throughout an urban environment. Ling (2004) found that mobile technology facilitates micro-coordination of social activities, which allows for users to redirection of trips that have already started, or coordination of transportation in real time. In an experiment which evaluated how feedback on one's travel history affects their awareness of their impact on the environment showed that for some segments of the population this feedback altered intentions for actual behavior change" (Carrel et al., 2012, p. 18). Researchers performing this experiment defined this experience as the 'Quantified Self', whereby a participant can record their behavior, process the collected data, and eventually feed it back to themselves so they will have a better understanding of their activity patterns, and eventually adapt their behavior more intelligently than they would without receiving this information (p.3).

A more legible urban landscape and constant access to real-time conditions for public transit, traffic, and social gatherings have drastically changed the way citizens interact with their surrounding environments. Townsend (2000) argues how the time-management capabilities of mobile phones are essentially quickening the pace of urban life, which increases the metabolism of urban systems (linked to the formation of decentralized information networks). Mobile devices have had an enormous effect on the daily routines of urban citizens, and planners will need to be able to predict and more effectively plan with these changes. A "re-examination of technologically constructed nature of space and time should be considered" when planners attempt to understand and plan for their local communities. An understanding of how mobile technologies alter human behaviors will help planners speculate how these changes will aggregate to cause larger transformations of neighborhoods, cities and regions (Townsend, 2000).

The mobile transition in planning

In planning the transition also appears to be significant. In a report written for the SENSEable City Laboratory at MIT, Carlo Ratti et al. (2006) discuss the significance of growing mobile usage on the urban planning community. They argue first "the widespread deployment of mobile communications, supported by personal handheld electronics, is having a significant impact on urban life," which was discussed in the previous section in detail. Secondly, they argue: "data based on the location of mobile devices could potentially become one of the most exciting new sources of information for urban analysis" (p. 2). With the accumulation of large amounts of anonymous and aggregated data, it will be possible to model the complex systems that exist in "living cities" and understand the multitude of activities and movements people make in space. Such analysis would be "a powerful tool to understand and control many phenomena occurring in urban areas."

Goggin & Clark (2009) explore how citizens have utilized mobile phones as a tool for new forms of expression and power in various community development efforts. Their research highlights cases where mobile phones have worked to strengthen the economic basis of community, in social networking and civil society, in health, and in empowering previously marginalized actors in communities. They argue: "the mobile phone offers an opportunity for innovative community development practice that responds to new circumstances, and forges new linkages among global, regional, and local levels " (p. 595). However, it is important the fundamentals of community organization are already in place in order for mobile technology to enhance community development and planning efforts.

Ray (2011) explores how social networking systems (SNS) have allowed planners to refine and extend engagement and data gathered through traditional participatory processes by leveraging user-contributed, spatially-referenced content freely available online. As previously mentioned, GIS technology is included in this large-scale citizen-initiated data collection, as it is becoming available to a larger number of "non-experts" (Lindolm, 1992). Goodchild & Sui (2011) discuss how social media is becoming more like GIS (equipped with mapping and location-based features), and how GIS is also becoming more like social media, as contributors of online mapping sites have begun to form communities for exchanging information (not always confined to the internet).

Sensors in hand-held mobile electronic devices have also allowed for a new approach for planning professionals to study the built environment. The increasing abundance of low-cost sensing devices paired with various social network platforms on mobile devices has led to a great deal of very specific data available for end-users. (Carrel, et al., 2012, p. 5). "It has been argued that knowledge creation often takes place on the move. This is especially true for urban planning, since planners frequently have to work in the field in order to assess the dimension of the problem on site.

Mobile computing and networking technologies can make a significant contribution in this type of scenarios providing tools allowing them to work outside the office" (Zurita, 2012, p. 6219). Mobile technology is thus able to act as an environmental sensing platform, which supports planning activities (Evans-Cowley, 2010, p.140). Evans-Cowley continues to explore the potential of mobile phones in sensing, documenting, and exploring the city, and argues that mobile technology has the potential to transform the city in various ways, as urban sensing can integrate various technologies to facilitate collaborative efforts between planners and the public.

These collaborative efforts can create larger-scale, publicly-initiated data collection, which can essentially lead to a radical rethinking of current planning assumptions. Cuff (2008) argues that mobile data collection will cause a shift away from a centralized model towards "distributed citizen-sensing," whereby a central authority (in this case, the planner) still maintains the centralized data repository and terms of collection, but citizens voluntarily and distinctively record data that is fed back to the central authority. In the "WikiCity" project, data from cell phones, buses and taxis in Rome for the 2006 Biennale of Architecture was aggregated to produce the Real Time Rome project. This project utilized sensors and real-time mapping of city dynamics, which proved to not only function as a representation of activities, but as a social instrument whereby citizens can change their actions and decisions in a more informed manner, and eventually lead to an overall increased efficiency and sustainability in making use of the city environment. Mobile sensors allowed researchers understand various transportation, communication, and social patterns in a real-time control system (Calabrese & Ratti, 2009).

Zurita's (2012) research integrates theory about visual geo-referenced data and information with a knowledge creation model, in order to provide a foundation to design a software tool for mobile devices that support urban planning activities in mobile scenarios combining face-to-face with computer mediated collaboration. This research continues to describe the advantages of utilizing mobile applications in the urban planning practice over stationary (immobile) activities, particularly with the process of knowledge creation that is geographically referenced. Zurita describes this model as a "Collaborative Spatial Decision Making system," which can aid planners in "collecting geo-referenced data and information, identifying locations according to a set of criteria, generating a brainstorm session, displaying and analyzing data, and decision making support" (p. 6219).

Mobile sensors can also help to understand and correlate more specific information about social identities and behavioral patterns within a certain environment. Ahas and Mark (2005) introduce the Social Positioning Method (SPM), "which uses the location coordinates of mobile phones and the social identifications of the people carrying them for the purpose of studying the space-time behavior of society." The SPM is a database that includes more precise movement information than that which would normally be obtained from travel diaries and questionnaire, and can be used for studying (1) the usage of infrastructure for commuting between city and suburb; (2) the temporality of urban space use; (3) the planning of transportation and infrastructure; and (4) marketing (p. 556). The rapid growth of location-based applications and positioning enables richer data sets, which demand more sophisticated analysis by planning practitioners (Evans-Cowley, 2010).

METHODOLOGY

The research conducted as a part of this study focused on 1) a survey issued to planning professionals about their use of web technologies and mobile applications, 2) the collection and categorization of planning-specific mobile applications in a database. Findings from those efforts were used to select a curated list for analysis and development of a taxonomy to guide use in city planning and governance. This methodology builds on research conducted by Evans-Cowley (2010) which provides a valuable background of literature regarding the use of mobile phones in the city and the implications for urban planning, and an online survey conducted by Evans-Cowley and Kubinski on the most effective mobile applications for planners.

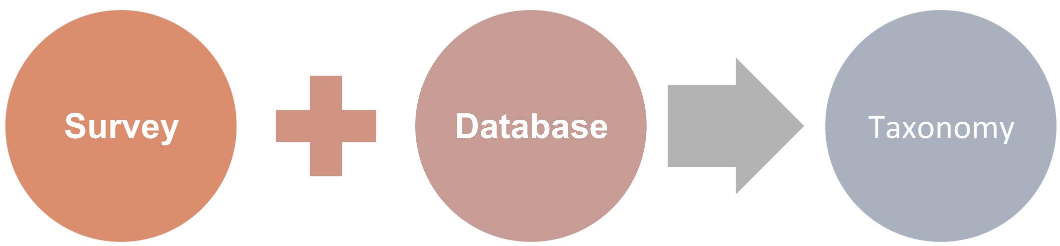

Figure 1. Methodology Process

Survey Development

In developing our survey we focused on the professional use of web and mobile technologies in parallel hoping to capture trends, attitudes, or opinions on technology use and transitions to mobile in the subject population (Creswell, 2014; Fowler, 2008). The survey included questions about the participants' professional use of web technology, as well as their use and adoption of mobile. Mobile technology was defined in the survey as: "any single purpose application software designed to run on smartphones, tablet computers and other mobile device." The word "Agency" was defined in this survey as: the workplace (business or organization) that provides some type of city and/or regional planning-related service.

Survey questions were designed to solicit data on the professional dependence on web and mobile technologies, the types of activities carried out using technologies, the types of software used in their daily work, mobile usage characteristics, barriers to using specific types of technologies, ideas for how technology could support professional activities, and basic demographic and employment characteristics. A total of 34 *optional* single-option multiple choice, multiple-option multiple choice, matrix, and open-ended questions were used to account for varying levels of time and interest each participant had to answer survey questions. These were arranged in the broad categories of “Your Professional Technology Use,” “Your Professional Mobile Technology Use,” and “About Your Agency/Workplace”. Open-ended questions were included in order to allow for less restrictive qualitative data. A complete list of survey questions and responses can be found in Appendix 1.

Participant Selection and Distribution

Since the purpose of the survey was to represent characteristics of the planning profession in general, we solicited participants from the most recent and publicly available data from the 2012 Governor’s Office of Planning and Research’s (OPR) “Directory of California Planning Agencies.” The allowed for the most representative sample of the subject population that would minimizing error in our analysis (Fowler, 2008). From this list we created a database of 481 public sector planners across California. One limitation of the OPR-derived database was that it represented only public sector planners in California. To mitigate this limitation, a link to the survey was posted on the city planning news website, Planetizen.com, which has a readership comprised of public and provide sector planners. We also posted advertisements and links to the survey in the newsletters for each division of the American Planning Association in California.

The survey was issued between March 4 and April 30 of 2014 using a University-sponsored web survey platform. It complied with Institutional Review Board (IRB) protocols. Survey participants were notified at the beginning of each survey that they were not required to participate in the study, could discontinue their participation at any time without penalty, and could omit any items they preferred not to answer. All responses were reported anonymously to protect the privacy of participants.

Overall, there were a total of 133 respondents. The demographic and employment characteristics of the participants of these respondents were consistent with the characteristics from a nationwide survey conducted by the American Planning Association, therefore, we assume that our survey and results are more or less representative of the larger body of city planning professionals. Consistent with our database, most survey respondents were located in California, with a few responses coming from the Northeast and Pacific Northwest. The majority of respondents were Male (65%), of White/Caucasian ethnicity (81%), with an average age of 41. Most respondents’ stated that they had earned a Master’s Degree (58%), followed by a four-year college degree (37%). This is consistent with the APA data, which found that the majority of current planning professionals were male (61%), of White/Caucasian ethnicity (86%), an average age of 44, and most had a Master’s degree (67%) or a Bachelor’s degree (26%).

Analysis

Findings from the survey were summarized using crosstabs and bivariate analysis in order to identify trends in web and mobile application usage by planning practitioners, understand how professional efficiency and interactions with community members could be improved with mobile technology, and understand the barriers which currently prevent planning professionals from utilizing various mobile technologies. Results were significant at the 90 percent confidence interval.

Additionally, survey analysis was used to draw comparisons between agencies in various sized jurisdictions, and create an overall summary of characteristics for planning professionals. Information collected from the survey responses were then statistically compared and evaluated based on a selection of taxonametric criteria used to classify mobile tools. To classify mobile tools a comprehensive database of approximately 130 mobile and tablet applications was compiled. The applications were selected by searches on the Apple iTunes Store, and the Google Play store. Searches involved the keywords "planning, urban planning, city planning, local government, community engagement, public input, and mobile applications," which were taken directly from the survey.

Information collected for each application included the following variables: 1) The application name, 2) Primary category (defined above), 3) Secondary category, 4) Platform(s) it is offered on, 5) A brief description, 6) A web link for its purchase and/or description, 7) Cost, and 8) Developer. The primary and secondary category for each application was established at a later time from the taxonomy system developed as a part fo this survey. The complete database of applications and corresponding information can be found in Appendix 2.

RESULTS

Web Technology

Of the professionals surveyed, 47% stated that the agencies for which they worked for were either very dependent on Internet technology, or could not operate without it (39%). In fact, only two respondents stated that their agencies' were not very dependent or could easily function without the Internet (Figure 2). Although the majority (91%) of respondents stated that every staff member had access to either a desktop computer or laptop in their agency, it is worthwhile to note that 9% of respondents reported that their agencies still do not provide access to either a laptop or desktop computer for each of their staff members.

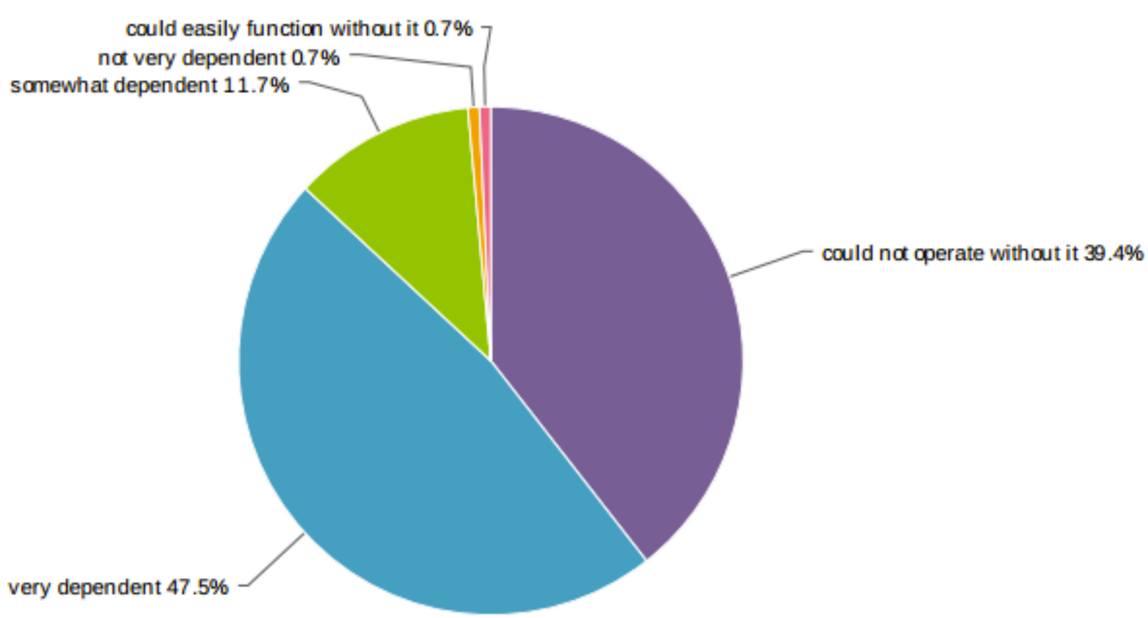

Figure 2. Dependence on Internet Technology

3% of respondents reported that their agency or division currently did not have a website. The main reasons cited were a lack of staff expertise to maintain the site, or no perceived need for a separate departmental website. When asked if they have felt pressure to increase web technology in the workplace, and if so, where that pressure came from, as shown in Figure 3, most respondents felt it stemmed from “citizens” (73%). Following that they cited “elected officials” (52%), “community groups” (36%), and “other private firms” or “government agencies”, 30% and 28%, respectively. Respondents also mentioned that they felt pressure to increase web technology from younger, internal staff.

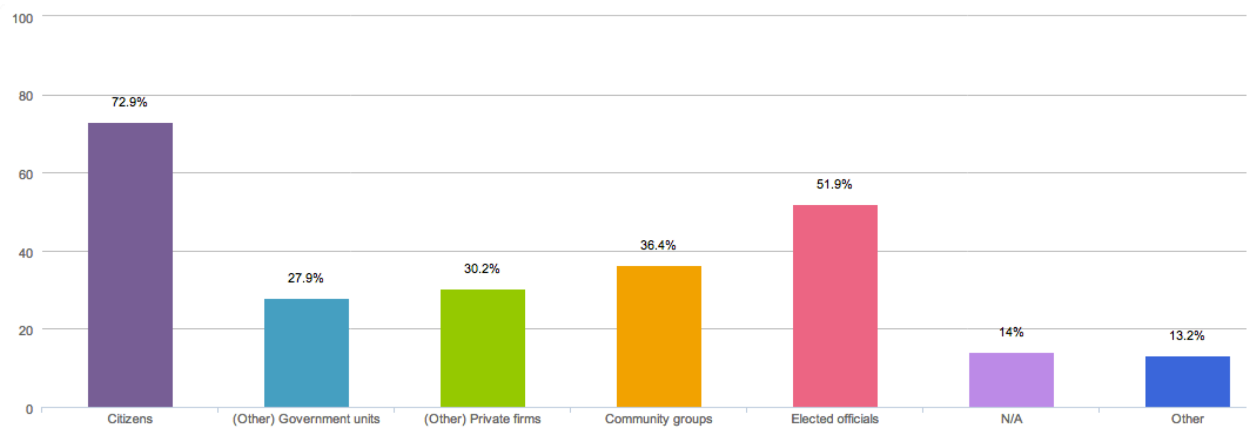

Figure 3. Pressure to increase web technology

Respondents were also asked about the interactions they performed through web technology and the types of software they used daily with the most common being email (82%), web search (73%), online forms (76%), job applications (65%), online audio/video streaming/live broadcasts (64%), and GIS/mapping (56%). The least common interactions were transactive uses, something the literature highlighted a primary area. This included web technologies were plan, code and permit activities such as filing for a variance (5%), purchasing copies of comprehensive plans (6%), virtual interaction (7%), and chat rooms/discussion forums (8%).

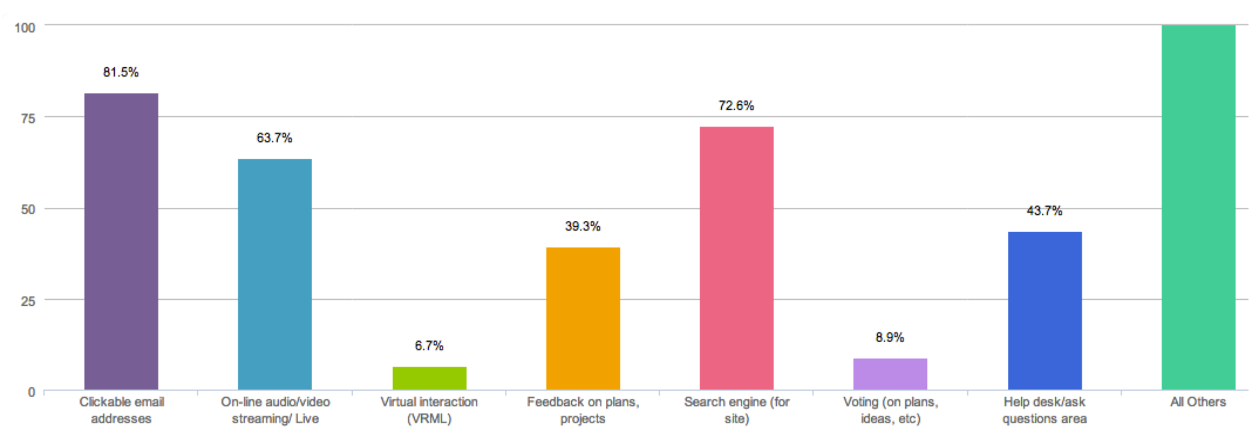

Figure 4. Interactions performed via web technology

Figure 5 displays the most commonly used software applications used by planners, which included word processing programs (used by 99% of respondents), email (99%), web-browsers (95%), spreadsheet applications (90%), presentation applications (82%), and GIS (73%). The least commonly used software included architectural design programs (5%), instant messaging (14%), statistical (18%), and web design (16%). Responses to these questions helped us understand the distinction between the various web interactions and technologies current planning professionals are utilizing as opposed to their mobile counterparts.

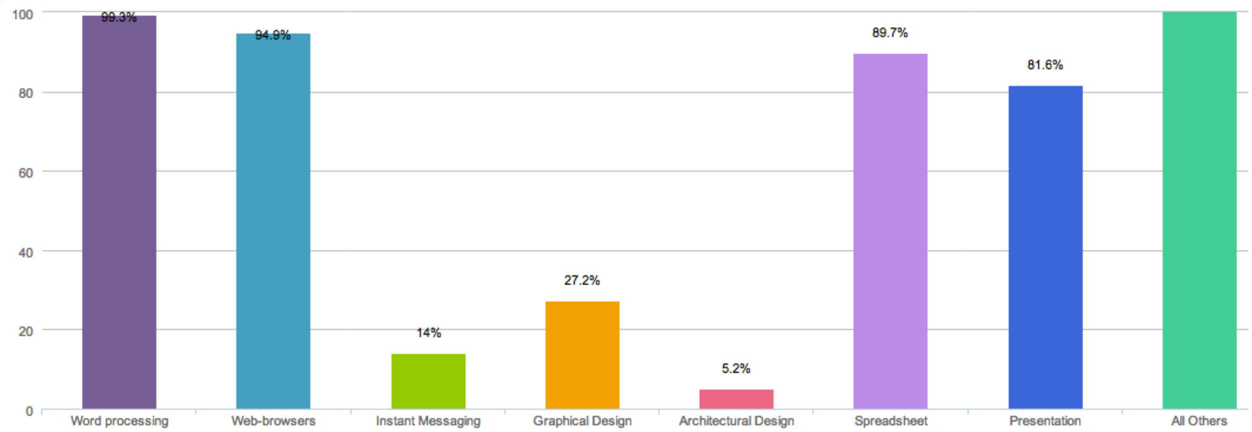

Figure 5. Commonly-used software applications

Mobile Technology

By comparison, with regard to mobile use habits in the professional setting, 93% of planners stated that they currently owned a smart phone or tablet device, however, only 74% stated that they use their smart phone or tablet for work purposes. Focusing on this population of mobile users we find that agencies are much less dependent on mobile technology than web technologies.

Of the professionals surveyed, 31% stated that the agencies for which they worked for were very dependent on mobile technology, 29% were somewhat dependent, and 22% not very dependent. As shown in Figure 6, for those who responded that they did not use their phone for work purposes, the primary reasons included: no perceived need (48%), and no demand by public or other agencies (22%). Similarly to general web technology, respondents felt pressure to increase their use of mobile technology in a professional setting mostly from citizens (43%), and elected officials (32%).

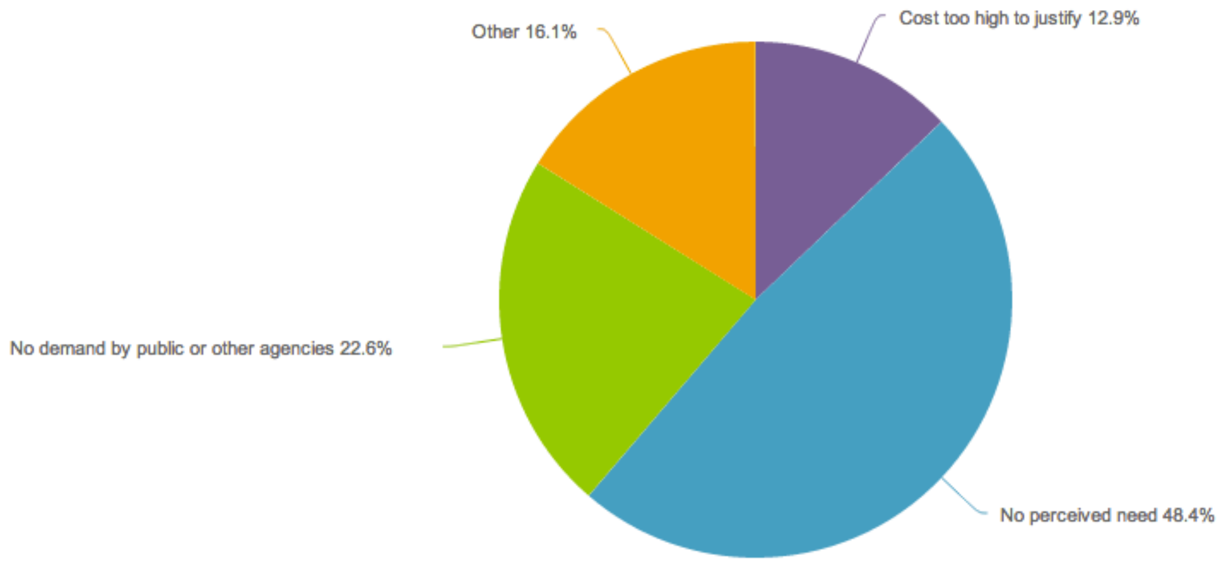

Figure 6. Reason for not using a smartphone for work purposes

The most common mobile software applications used by respondents differed slightly from web-based applications. As shown in Figure 7, most respondents stated that they used mobile email (94%), web-browsers (66%), and instant messaging (34%). The least commonly used mobile applications included architectural design (0%), web design & animation (1%), graphical design (1%) and statistical applications (2%). A variety of mapping and mobility service applications were cited in open-ended responses, however by an large despite the inclication of the literature planners appear to be engaging more in informative or interactive activities, and not in those that are transactive using their technology.

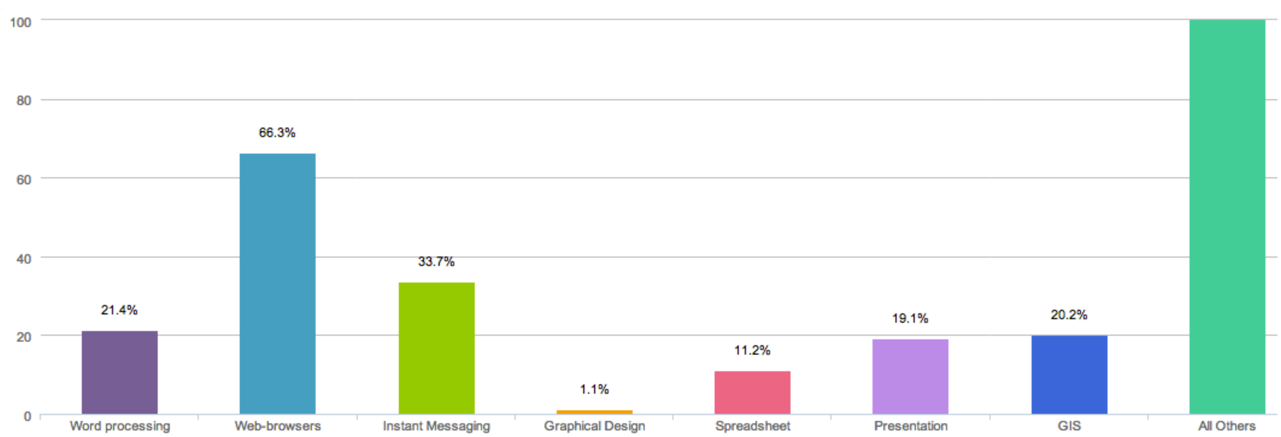

Figure 7. Mobile software used professionally

Respondents who currently owned a smartphone were also asked about the type of interactions they complete via mobile devices or tablets. Similarly to general web technologies,

Figure 8 shows that respondents mostly used mobile email (60%), search engines (50%), online audio/video streaming (24%), and GIS/mapping (27%). Social media apps (such as Twitter, LinkedIn, and Facebook) were the most commonly used applications by planners on a regular basis. Note-taking mobile apps (such as Notes and Evernote) were used a few times per week by 17% of respondents, and file-sharing apps (such as Dropbox and Box) were used by 15% of respondents a few times per month. However, the majority of respondents (80%) stated that they never used planning specific applications.

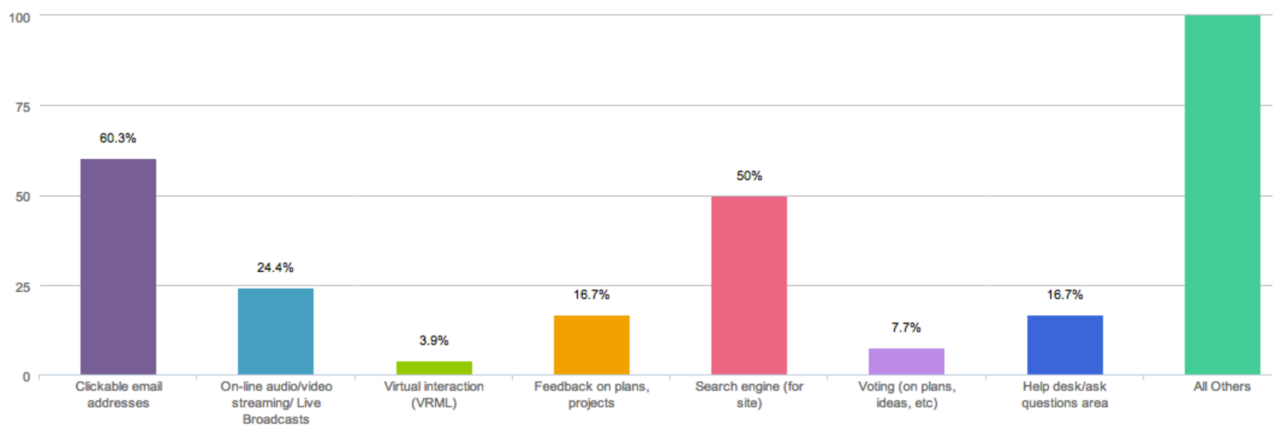

Figure 8. Interactions completed via mobile technology

Of the 20% who are currently using planning specific applications to support their work, many mentioned: Google Earth, Evernote, Notes, Dropbox, Safari, Excel, MapQuest, and other social media applications. Some of the more "uncommon" and noteworthy apps cited included:

- iLegislate: iLegislate is a mobile agenda application created for the iPad, which enables governments to review meeting agendas, supporting documents and archived videos. The benefits of this application include reduced costs for printing and copying materials, reduced staff hours for pre-meeting activities, and reduced staff costs for collecting, organizing and distributing meeting materials. Elected officials and staff members can annotate agendas and PDF attachments while offline and update to the latest information and data when online. https://www.granicus.com/products/ilegislate-mobile-agenda-ipad-app/

- Tableau Data Visualization: Tableau is another application made specifically for the iPad and Android tablet that allows users to drag & drop to analyze data. Users can publish interactive dashboards to the web to embed in a SharePoint site or view them on a tablet. Viewers need only a web browser or tablet to filter, sort, and answer questions anywhere and anytime. https://itunes.apple.com/us/app/tableau-mobile/id434633927?mt=8

- GoRequest: GoRequest is an application that allows citizens to directly report issues in their neighborhood to their local governments. The user selects an issue, takes a picture, and the app sends that information along with the user's location

to the responsible city agency.
https://itunes.apple.com/us/app/gorequest/id351223716?mt=8

Respondents were also asked about the type of applications they would like to see developed in the future which did not currently exist (that they had no knowledge of), and if their agency intended to develop mobile applications in the future. Responses fell under four main categories: (1) Transportation; (2) Interactive Applications/City Reports; (3) Utility; and (4) Outreach & Communication.

1. Transportation
    - Many respondents stated that they would like to see an "all-in-one" transportation system application, interfaced with real-time travel using accelerometers and cross-modal capability.
2. Interactive Applications/City Reports
    - Suggestions also included applications that would give users access to full departmental and City databases, and enable users to check the status of land use and planning applications.
3. Utility
    - Respondents also mentioned the need for various utility-type applications, including a floor-area-ratio calculator, an app to report field observations, and an app that would upload photos for report completion.
4. Outreach & Communication
    - Respondents also stated that they would like to see more outreach and communication tools for ad hoc polling and crowdsourcing data.

With regard to future applications, 85% of respondents stated that their organization has not developed any applications, but 25% of respondents said that their agencies had discussed creating one in the future. For agencies that had developed an more transactive applications with their constituencies, responses included:

- Code enforcement applications
- Dining guides
- GIS related
- Citizen service request
- Traffic applications
- Permit tracking
- Land use and employment mapping

DISCUSSION

Given the summary survey results, there are clear opportunities for growth and expansion of mobile technology especially in transactive and interactive areas. This is a factor that is gaining importance as the many citizens transition away from desktop computers to mobile forms of access. These opportunities also present opportunities and barriers worth exploration and discussion. New forms of access are needed in urban planning and public policy to match these changing needs, breaking down barriers and developing a clear roadmap for use and adoption of mobile tools by local planning agencies – what we call a taxonomy.

When looking at open ended qualitative responses, commonly cited barriers included budgetary concerns, time, lack of staff and staff expertise, not enough support from elected officials or community members, security concerns, maintenance support, and lack of IT infrastructure or compatibility – items illustrated in the scaled word cloud in Figure 9.

Figure 9. Barriers to Mobile

While many of these items may be grounded in the public sector pressures of fiscal constraint (given mentions of cost, funding, money and budget) or lack of personnel, they are counterbalanced by the recognition that there would be a tangible benefit and one that would likely work against these limitations. As indicated in Figure 10, many respondents noted how mobile applications had the ability to improve **workplace efficiency** and **collaboration** and streamline **repetitive processes**, both of which could be related to cost savings and improved fiscal management. Furthermore many cited better ability to do **community engagement**, improve **access to data**, **disseminate important information** more quickly and to a wider audience, and to improve levels of **customer service** which some suggest could be tied to reduced staffing based on crowdsourcing and higher levels of community involvement and participation.

Figure 10. Benefits of Mobile

Furthermore when looking at the size of cities for each response, the argument against exploring greater levels of mobile technology diminishes. When looking at these in cohorts it is clear that small cities can gain significantly by being adopters. For example, when we compared population size with each agency's dependence on mobile technology, smaller cities appeared not only to have the most potential for growth but also to have the most potential for growth and expansion. As shown in figures 11 and 12, a much larger percentage of agencies are "not very dependent" on mobile technology which serve populations less than 75,000 people, and agencies in larger jurisdictions are either "somewhat or very dependent" on mobile technology. There was also almost double the number of agencies which stated they could "easily function without" mobile technology in smaller jurisdictions, and 10 percent more used mobile technology for work purposes.

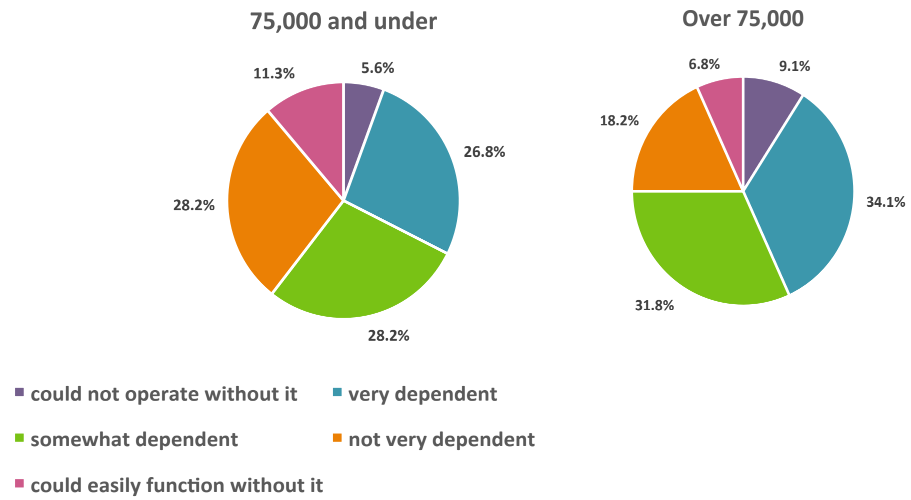

Figure 11. Dependence on mobile technology by population cohorts

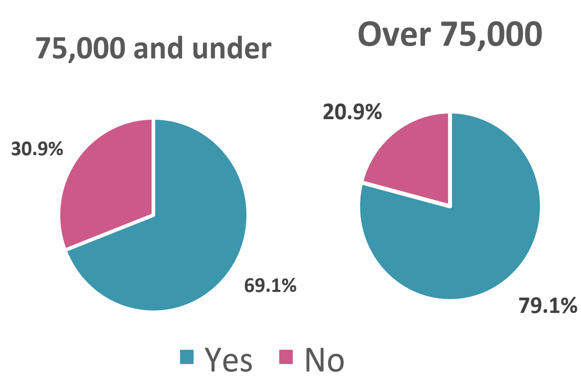

Figure 12. Smartphone/tablet use for work purposes by cohort

These findings indicate untapped potential—although agencies in smaller jurisdictions have more access to a desktop and laptops, they do not utilize their potential to integrate mobile technology for professional activities. Although this research shows variations in technology adoption and use according to the population sized served by different planning agencies, it should be noted that many other economic, political, geographic and social factors could influence trends in technology adoption. While further research is needed to evaluate the influence of these exogenous factors on the mobile use, , it remains clear that such an emphasis on mobile is likely to grow and to support this a common language or taxonomy for mobile application use and adoption is needed.

Developing a Taxonomy

Given this need, we propose a taxonomy for planning applications based on research by Nickerson et al. (2009) while provides taxonometric rules – that they should be concise , inclusive, comprehensive, and extendable. Given this framework, the first consideration to determine the "meta-characteristic" that will serve as a basis for the classification. For practicing planners, we argue that this should be related to the specific *use* of mobile applications, and not in their hardware or software characteristics. Again, since our purpose of developing taxonomy is to determine the capability of each application to support professional planning activities, it is important to distinguish among the applications based on how planners will interact with them. Therefore, the meta-characteristic for developing our taxonomy is the interaction between the planner and the mobile application.

Using our compiled database of available mobile applications we use a deductive approach to determine user interaction characteristics of the various applications. According to Nickerson (2009), a taxonomy of mobile applications "is based on the meta-characteristic of the interaction between user and the application, and consists of seven dimensions: temporal, communication, transaction, public, multiplicity, location, and identity." For our taxonomy, we identify five different types of interactions planners would have with the mobile applications based on the publicly available application descriptions:

App Category	Information Flow	Description
Informational	**application→planner**	Applications that make information more widely available to planning professionals.
Transactional / Interactive	**citizen→application→planner**	Applications that allow for citizens to participate and share their input on a variety of planning activities and projects.
Utility / Productivity	**planner→application**	Applications that offer some type of tool or project management platform to support planning workflow efficiency.
Virtual Reality / Gaming	**planner→application**	Applications which involve a computer-generated simulation of an image or environment that help make complex scenarios more clear.
Wayfinding	**citizen→application→planner**	Applications which collect data on citizens' navigation habits, including orientation, route decisions, route monitoring, mode of transportation, and route times in order to improve the effectiveness of those services.

Table 1. Application taxonomy descriptions

To distinguish between "Informational" and "Transactional" applications, it is important to understand the directional flow of information. For applications categorized as "Informational", information solely flows from the application to the user (in this case, the planner). Applications categorized as "Transactional/Interactive" allow for a multi-directional flow of information. For our purposes, the "transactional/interactive" category includes applications that planners might not directly interact with, but rather, information collected from a larger body of citizens who do interact with the application is released to the planner to support their professional activities.

Applications categorized as "Utility/Productivity" offer some type of tool or project management platform to support planning workflow efficiency. Virtual Reality & Gaming applications may not directly support professional activities, but could help planners better understand the image of the city "since the representation of urban space in citizens' minds plays an important role in the alteration of real space," (Hanzl, 2007). Thus, virtual reality and gaming systems can help planners better understand the citizens' image of the city by "making complex alternative scenarios more clear and accessible allows for increased potential citizen participation and a more satisfactory planning process," (Simpson, 2001). "Wayfinding" was added as a fifth category to include directional applications which also do not serve a particular "planning" purpose, but do change the way citizens interact with and move about their environments. These applications ultimately have an indirect influence on planning activities, as data collected from them could help planners understand which modes of transportation citizens' use, specific routes and pathways, and route time data.

After establishing the initial five dimensions were established, we utilize a deductive approach to establish subcategories, which help to further define the specific role the applications play in planning activities. Under the "Informational" category, we distinguished between three types of informational applications: static, dynamic, and alert. Static and dynamic are related to the locational dimension of the applications: some applications provide customized information or functionality based on the user's location, whereas other applications do not depend on where the user is located. (Nickerson et al., 2009). For our purposes we have labeled "location-based" applications as "dynamic," and non-location based applications as "static," since they do not use the user's location to modify the user interaction. The "alert" subcategory is related to the temporal dimension of the application, and consists of informational applications that interact with the user in real-time. These types of applications mostly involve emergency-related information, which is extremely time-sensitive.

The two subcategories for "Transactional/Interactive" applications include: crowdsourcing/input and reporting. Crowdsourcing/Input applications allow solicited user input from a larger community that contributes to a larger body of information. Reporting applications are mobile civic engagement tools that encourage residents to report a variety of issues throughout their communities. Input from these applications are not assembled into a large body of publicly available information (as crowdsourcing applications are), but are instead reported directly to the city government or planning staff connected with the application.

The three types of defined "Utility/Productivity" applications include: data collection and analysis tools, project management and collaborative platforms, and presentation/annotation tools. As for "Wayfinding" applications--which we described earlier do not directly influence planning activities, but instead provide information relevant to making planning (especially transit) related decisions—we distinguish between the synchronous and asynchronous. In synchronous applications, the user and application interact in real time (similarly to "Alert" apps), which means that the application services the user's request almost immediately. For asynchronous applications, the user and application interact in non-real time. Thus, asynchronous wayfinding applications only include static data for maps and route information, and synchronous wayfinding applications involve "real-time" updates to transit, traffic, and route times. We did not determine any subcategories for the "Virtual Reality/Gaming" dimension. The final taxonomy developed for the database of applications is presented in Figure 13.

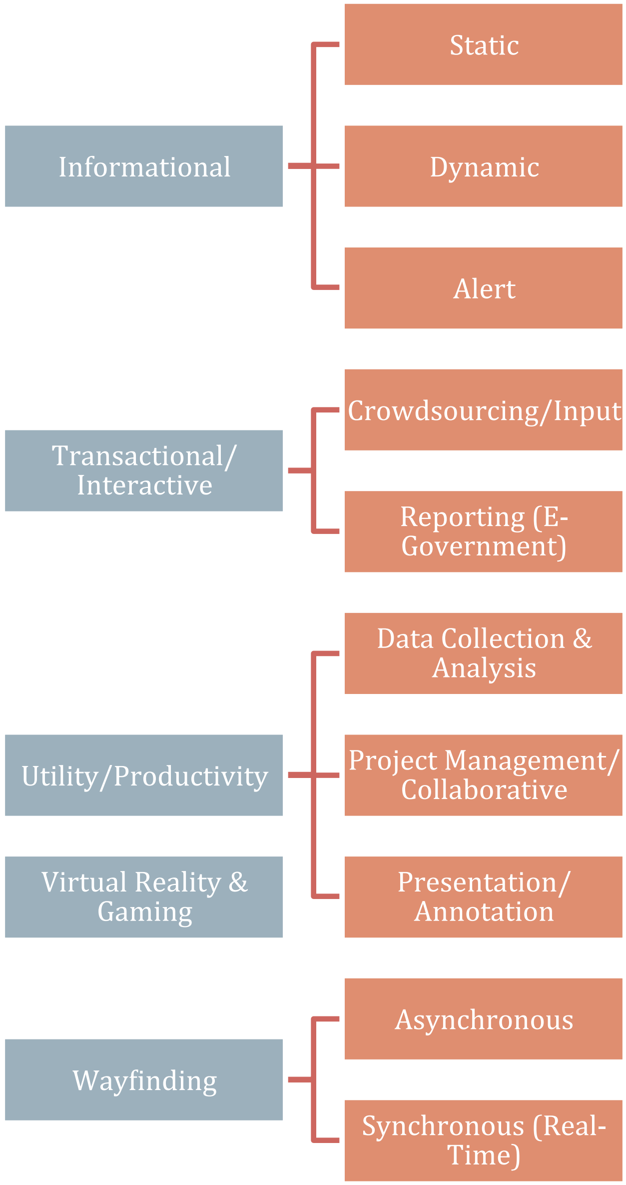

Figure 13. Final taxonomy

CONCLUSIONS
Many planning organizations and agencies are beginning to understand the ways in which different web and mobile technologies improve workplace efficiency, increase access to information, streamline repetitive processes, and improve communication processes both internally and with the general public. Local governments and planning agencies are beginning to not only realize that smartphones have the ability to gather massive amounts of data about citizen actives and preferences, but that the phones allow them the opportunity to engage with the now *160 million American adults* who own a smartphone (Pew Research Center, 2013).

Findings from this study show that although many planning organizations are slowly beginning to adopt various web and mobile technologies, they are also beginning to feel pressure to increase their use of those applications from citizens and elected officials. Although 93% of survey participants stated they currently own a smart phone or tablet, only *a third* of participants also stated that they are "very dependent" on mobile technology to support their work, with the remaining two-thirds of respondents citing "no perceived need," to integrate mobile technologies into their daily professional work. Given the cost verses benefit of investing in mobile technologies, some jurisdictions do not have the resources or time available to prioritize the implementation of risky and costly technologies. Especially in smaller jurisdictions and developing communities, it can be argued that an investment in advanced communication technologies would be better spent to develop and maintain basic core infrastructure and services.

However, the purpose of this research was to explore the present and potential role of mobile technology in planning practice and public agency management, so that when a time comes for a city or community to invest, they will have a better understanding of how mobile technologies can offer several advantages over traditional practices and web-based technologies. Alshuwaikhat & Nkwenti (2003) also argue that the absence of technologies 'make it even more difficult for [governments] to see associated problems, thoughtless of providing meaningful policies to regulate their deployment" (p. 296).

Mobile technologies embody both time-context and location-context attributes which can eliminate many time and space restrictions for traditional planning activities. Since many people don't have the time to attend public meetings, mobile devices allow for the user to engage at any time, and without any time frame restrictions. "As a resident, you can weigh in on a local zoning dispute without getting sucked onto an voluminous email list. You can report a downed stop sign or graffiti outbreak without wandering the automated phone maze of City Hall" (Badger, 2011). Location-based technologies also enable planning professionals to collect and analyze "user activity, movements and behaviors in real-time conditions and specific contexts" (Kwak, Lee, Park & Moon, 2010).

Although very few respondents stated that they were dependent upon mobile technologies for their professional work, many expressed interest in the development of more applications that would 1) Give them access to real-time transportation data; 2) Allow access to full departmental and City databases and applications; 3) Improve their productivity (such as utility-based applications); and 4) Improve their outreach and communication efforts with the public. In order to address this need, we compiled a comprehensive list of current mobile applications which could benefit professional planning activities, and developed a taxonomy of applications in order to categorize the ways those applications are supporting such activities:

- **Informational –** Applications which make information more widely available to planning professionals
- **Transactional/Interactive –** Applications that allow for citizens to participate and share their input on a variety of planning activities and projects.
- **Utility/Productivity -** Applications that offer some type of tool or project management platform to support planning workflow efficiency.
- **Virtual Reality & Gaming –** Applications which involve a computer-generated simulation of an image or environment that help make complex scenarios more clear.
- **Wayfinding –** Applications which collect data on citizens' navigation habits, including orientation, route decisions, route monitoring, mode of transportation, and route times in order to improve the effectiveness of those services.

Survey results from this study show that most respondents are currently using very basic "productivity" type software mobile and web applications, including word processing programs, instant messaging, email, web-browsers, presentation applications, and GIS. In fact, the most cited applications in the survey included email, Google Earth, Dropbox, and Notes. However, there is a slower rate of adoption for using more complicated technologies such as virtual interaction, collaborative design, statistical applications, and community engagement platforms. These applications, which would be considered "planning-specific" according to our taxonomy, have the unique ability to support many planning activities, such as collecting survey responses for community outreach, or streamlining data collection activities such as a land use inventory or traffic counts.

We propose the following question: Do we need planning-related applications, or are the existing generic productivity and utility applications sufficient for current planning professionals? The perceived lack of adoption for planning-specific applications could be caused by: (1) no perceived need to integrate mobile technology into planning activities, (2) a lack of knowledge about mobile technology in the planning profession, or (3) a cost-benefit analysis is that it's not worthwhile for cities to venture into this fast-moving marketplace yet.

Results from our survey also show that the most common barriers to implementing or developing mobile applications to support planning work include budgetary concerns, lack of staff time and expertise, and lack of IT infrastructure or compatibility. Technology is not created equal—the implementation of new applications and software requires time, expertise, and money that not all planning jurisdictions have access to equally. Although the mobile phone facilitates a more collaborative planning process, a streamlining of repetitive processes, a decentralization of data gathering responsibilities, and richer data sets with real-time and location-based information, planners "must begin to recognize the importance of technical literacy in planning practice, at the risk of creating an increasingly-untenable disconnect between their technical skill and those of the general public (Ray, 2011, p.10).

What should be understood then is, that technology offers the ability to enhance and alter planning processes, but should not be a direct replacement for in-person interaction (Gordon &

Koo, 2008). It is evident that mobile technology is beginning to alter not only the way that citizens interact with their environments, but the way in which we understand those changes and interactions as well. Planning professionals will have the opportunity to take advantage of these technologies in order to better understand characteristics of those whom they plan for, how they interact with their surrounding environments, and how they would envision changing the environments they live in.

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