THE USE OF MOBILE TECHNOLOGY IN PROFESSIONAL PLANNING AND LOCAL GOVERNMENT PRACTICE

A Thesis

presented to

The Faculty of California Polytechnic State University,

San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Master of City and Regional Planning

by

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June 2014

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ABSTRACT

The Use of Mobile Technology in Professional Planning and Local Government Practice

Kayla Michelle Gordon

As advances in web and mobile technologies have rapidly changed the world of businesses, they have also begun to fundamentally change the way local governments understand and interact with their communities. In an effort to evaluate the use of online and mobile technology for government work, this thesis examines the use of mobile technology as a vehicle for local government practice, specifically looking at the field of urban planning. 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 et al., 2010). This paper (1) explores 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. Findings from a survey of local planning agencies about their interactions with web and mobile technologies demonstrate that although many planners own a smartphone or tablet and are aware of existing mobile potential, they are not entirely dependent on those devices for work purposes. Currently, many planners take advantage of basic productivity software (email, word processing, search engines, online forms, etc.), but do not utilize planning specific mobile applications to support their work. Despite pressure from citizens, elected officials, and younger staff members to integrate more interactive technologies in planning work, there are often numerous barriers to implementing mobile technologies, especially for agencies in smaller jurisdictions.

Keywords: mobile, technology, applications, city planning, local government

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CHAPTER ONE: 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. Findings from this paper will (1) explore how mobile technology is currently influencing planning practices, (2) define a taxonomy for current mobile applications, and (3) hypothesize how these technologies will influence the future of the planning profession.

Relevance to Planning

Findings from this paper may prove useful in improving the capacity of planning practitioners to select which mobile technologies best serve their local needs. This involves a better understanding of which mobile technologies are currently available in the marketplace, under which circumstances those technologies would be beneficial for their practice, and which audiences they can involve.

CHAPTER TWO: METHODOLOGY

Research for this thesis was primarily centered on 1) a literature review which provided background on the current state of mobile technology use in city planning, 2) a survey issued to planning professionals about their use of web technologies and mobile applications, 3) the collection and categorization of planning-specific mobile applications in a database. Findings from those efforts were used to select a curated list of the twenty most “valuable” mobile applications for planning professionals based on a series of established criteria.

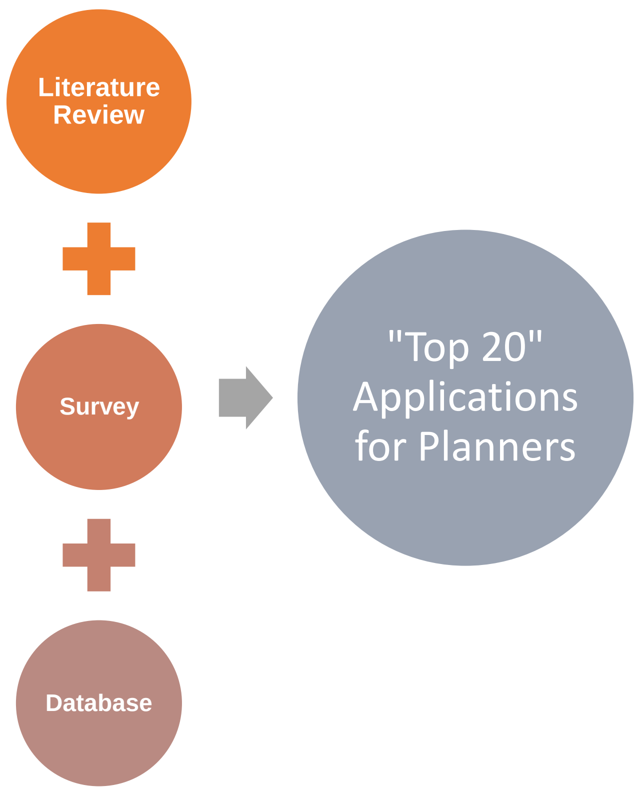

Figure 1. Methodology Process

Literature Review

A detailed literature review helped to refine the research question, identify gaps in current literature surrounding mobile technology and planning, and establish the research direction. Secondary data was initially reviewed through the university library using a range of information sources including library databases, academic abstracts and journals, and Internet searches. A list of key terms was used to aid research on the integration of technology in local government practices (with an emphasis on urban planning), and past and emerging trends involving the application of mobile technology in planning activities.

Primary Question

From the literature review, the research question was developed to identify and address gaps in current research concerning technology and planning. Prior research on the categorization and evaluation of various web and mobile applications, especially related to the planning profession, provided insight for the methodology structure and techniques used in this paper. Research conducted by Jennifer Evans-Cowley (2010) in *"Planning in the Real-Time City: The Future of Mobile Technology,* provided a valuable background of literature regarding the use of mobile phones in the city and the implications for urban planning. A survey conducted from July of 2011 to July of 2012 by Professor Evans-Cowley and Brittany Kubinski on the most effective mobile applications for planners helped in developing survey questions used in this study. This thesis attempts to build on the research done by Evans-Cowley and Kubinski, and provides a comprehensive and updated list of mobile applications for the planning profession.

Survey Development

An online survey was conducted to gather primary source data from planning practitioners across the United States in order to understand how technology use is changing for local government officials and city planning practitioners with the increasing use of mobile technology. The survey collected qualitative data on the professional use of web and mobile technologies in the city planning profession, which helped to provide a quantitative description of trends, attitudes, or opinions of the respected population (Creswell, 2014) generalized from a sample to a population (Fowler, 2008).

Survey questions were developed to understand how mobile applications are being adopted in the planning profession. A total of 34 *optional* single-option multiple choice, multiple-option multiple choice, matrix, and open-ended questions were used in order to account for varying levels of time and interest each participant had to answer survey questions. Open-ended questions were included in order to allow for less restrictive qualitative data. The questions were developed so as to understand 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. Broad categories of “Your Professional Technology Use,” “Your Professional Mobile Technology Use,” and “About Your Agency/Workplace,” were used to organize survey topics. A complete list of survey questions and responses are included in the Appendix of this report.

Participant Selection

Since the purpose of the survey was to provide statistical estimates of the characteristics of the planning profession in general, we designated a sample of that population from whom we collected information in order to minimize error in our estimations (Fowler, 2008). In order to obtain a representative sample of planning professionals, research was conducted using a public database of city planners across California. The most recent and publicly available data found was from the 2012 Governor’s Office of Planning and Research’s (OPR) “Directory of California Planning Agencies.” From this directory, a list of 481 Planning Directors and their contact information was collected for every city in California. The first round of online surveys was distributed to each city in the database using a University-sponsored web survey platform, SurveyGizmo.

One shortcoming of the OPR Directory was that it represented only public sector planners in California. In order to mitigate this limitation, a link to the survey was posted on the city planning news website, Planetizen.com, which has a daily national readership. The survey was also distributed to another selection of planning professionals using a Florida State University Transportation TMD list serve. This helped increase the sample to include private sector consultants and other regional and state planning professionals. Overall, the survey had a total of 133 responses.

The demographic and employment characteristics of the participants of our study were fairly consistent with the characteristics from a survey conducted by the American Planning Association to a larger sample of planning professionals across the United States. Therefore, we assume that our survey and results are more or less representative of the larger body of city planning professionals.

The final survey complied with Institutional Review Board (IRB) protocols, and all responses were reported anonymously to protect the privacy of participants. 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.

Survey Analysis

Findings from the survey were summarized (see Chapter 4 of this report) 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. 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 criteria, described in detail in Chapter 5.

Application Inventory

Following this quantitative work, a comprehensive database of about 130 mobile and tablet applications was compiled to supplement survey data and serve as the second level of analysis for this study. The applications were selected using a basic Internet search and searches on the Apple iTunes Store, and the Google Play and store. Searches involved using 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 discussed in Chapter 5 of this Report. The complete database of applications and corresponding information can be found in the Appendix.

Final Application Selection

Based on the results of the survey, a selection of the “top 20” mobile applications for planners were selected. These applications were chosen based upon the following criteria:

1. Having been mentioned in the survey.

2. Having the “planner” as the primary user or receiver of information from the application, as opposed to any other professional user or citizen.

3. Specific relevance to the planning profession or a planning-related activity.

4. Availability in different locations.

5. Availability across a variety of mobile platforms (e.g. iOS, Android, etc.)

6. Recent software updates/availability of up-to-date information.

If the application met the above criteria, they were selected as one of the “recommended” applications for planning professionals. A more detailed description of the categorization and selection process is provided in Chapter 5.

CHAPTER THREE: LITERATURE REVIEW

Introduction

This section reviews the literature surrounding the integration of various technologies in local government practices, specifically focusing on urban planning. [1] This chapter begins with an examination of the various manners in which citizens have historically interacted with local government agencies off-line in order to better understand the types of interactions that can occur through technological platforms. This is followed with a historical discussion of the adoption of technology in the public sector, focusing on past and emerging trends involving the application of *mobile* technology in urban planning activities.

Citizen Interaction with Local Government

One way of examining the role of government as it occurs on-line is to look at the manner in which citizens interact "off-line." 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

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[1] The reason urban planning has been chosen as a focus of analysis is because it can be considered representative of the various forms of interaction that occur between government and its citizens. Planning agencies are a microcosm of the various interactions that may occur in any given public agency, in that they include, in one place, several levels of interaction (identified as receptive, interactive and transactive, below). The focus is on local (municipal) planning agencies because they are the unit that often affects people at the "lot" level, and planning agencies actively seek community input for short and long range planning issues and plans.[1]

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:

Information Seeking (Receptive Mode)

Similar to the "information sharing" tools described in "E-government," 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.

Interactivity and Public Participation (Interactive Mode)

As defined in "E-government," 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.

E-Business (Transactive Mode)

There are also interactions that involve a monetary exchange between planning 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.

These three types of transactions represent the various manners in which citizens and planning agencies interact “off-line.” Through technological advances, these interactions have been translated to web platforms in order to potentially better government performance. Accessibility to these functions for those with alternate working hours, physical limitations, or other restrictions would now be available 24 hours a day. There is no question that the web has the potential to alter the way community residents interact with their local government, however, the assumption that it increases performance has yet to be evaluated.

The Adoption of Technology in the Public Sector

Over the past years, the capabilities and processing speeds of computers have dramatically increased. 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* (2000), 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," Bill 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, 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.

Regardless of the type of technology that is being used by both planners and citizens, it is obvious that technology has allowed citizens to contribute their expertise and ideas to the planning process. The following discussion will review how the introduction of the mobile phone has provided additional opportunities for both information sharing and interactive processes between planners and citizens.

The Rise of the Mobile Phone: How Mobile Technology Influences Human Behavior and Interactions with Urban Environments

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 Transition to Mobile in Urban Planning

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).

Conclusions

The mobile phone has allowed for more collaborative planning processes, a decentralization of data gathering responsibilities, and richer data sets with the introduction of geo-referencing technologies. However, "considering the growing use of technology, and more significantly the growing expectation for public processes that are technology-facilitated to some extent, 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). The literature indicates that it will become increasingly important for planning professionals to not only understand the merits of mobile technology, but to also understand and rethink current power relations of planning and development practices. (Goggin and Clark, 2009, p. 594). While the introduction of new technologies have often been seen to deepen the socioeconomic divide in regards to technology use and competency, smartphones and mobile applications might offer the chance to create "better ways to communicate and allow new voices into the development [and planning] process," which would ultimately help to decrease the digital divide in local government operations (Goggin and Clark, 2009).

Given the cost verses benefit of investing in mobile technologies, some jurisdictions might not have the resources or time available to prioritize the implementation of risky technologies. However, the purpose of this research is to explore the present and potential role of mobile technology in planning practice and public agency management, so that when the time comes for a city or community to invest, they will have a better understanding of one of the "most exciting new sources of information for urban analysis," (Ratti et al., 2006).

CHAPTER FOUR: SURVEY FINDINGS AND RESULTS

Introduction

From March 4, 2014 until April 30, 2014 we conducted a web-based survey on a cross-section of planners to better understand how technology use is changing for local government officials and city planning practitioners with the increasing use of mobile technology. The survey included questions about the participants' professional use of web technology, as well as their use of mobile applications. Mobile applications were 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. Overall, the survey received a total of 133 respondents.

Respondent Demographic & Employment Profile

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%) (Figure 2). The majority of respondents (62%) were current members of the American Planning Association (APA), and 34% had an American Institute of Certified Planners (AICP) certification.

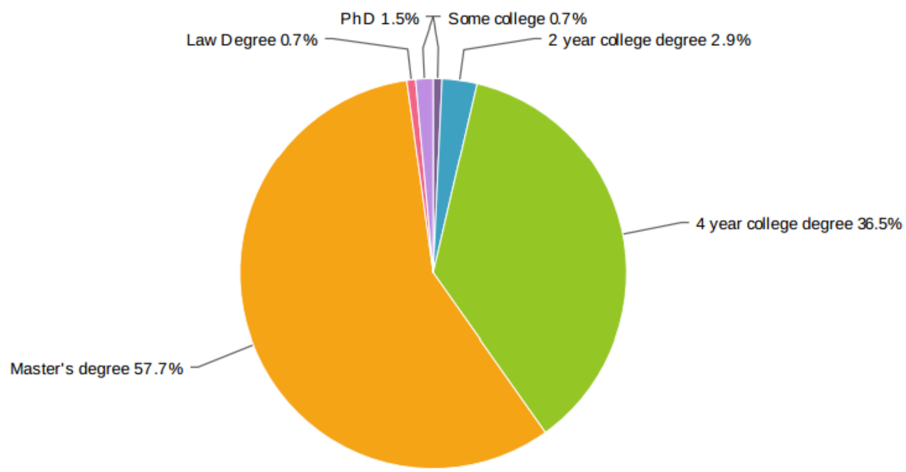


Figure 2. Highest degree earned

Most survey respondents (80%) were located in California, with a few respondents coming from the East Coast and Pacific Northwest. The majority (91%) stated that they work in public sector planning and 5% work in private sector planning. A total of 47% of respondents stated that they have been working in the planning profession for 20 or more years, with the remainder of respondents being evenly distributed between fewer than 5 years (15%), 5 to 9 years (13%), 10 to 14 years (12%), and 15 to 19 years (12%) (Figure 3).

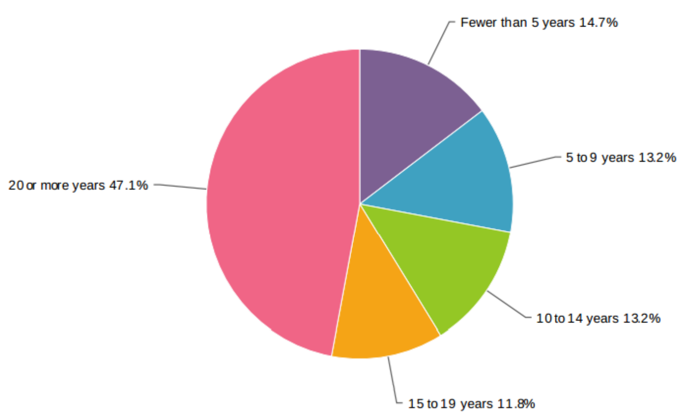


Figure 3. Time working in planning profession

The majority of respondents stated the city (72%) was the boundary of their service area, and the average population size served by the respondents' agency is 557,000 people. Most of the respondent's agencies (58%) currently employ over 30 full-time staff, and 29% work for agencies that employ 10 or fewer people (Figure 4).

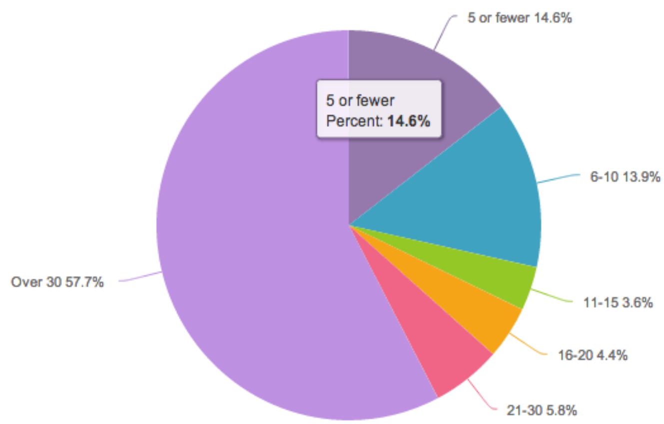


Figure 4. Full-time staff employed by agency

Based on the demographic and employment profile of this survey, we can assume that our survey results are representative of the larger body of city planning professionals, as the demographics are fairly consistent with the profession as a whole, as demonstrated by the American Planning Association (APA). According to an employment survey conducted by the APA on a sample of planning professionals across the United States, the majority of current planning professionals are male (61%), of White/Caucasian ethnicity (86%), and an average age of 44. They found that most planning professionals' highest degree earned is a Master's degree (67%), followed by a Bachelor's degree (26%).

Technology Profile

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' are not very dependent or could easily function without the Internet (Figure 5). 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.

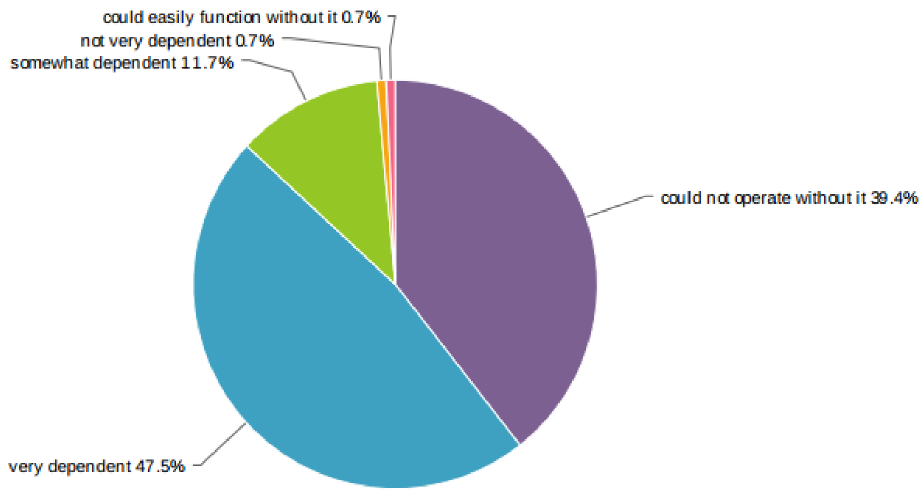


Figure 5. Dependence on internet technology

Most of the planners surveyed (97%) said that their agency currently has a website, and 79% stated that there is at least one staff member dedicated to Information Technology in the office.

Of those whose agency currently did not have a website (3% of respondents), the main reasons were cited as a lack of staff expertise to maintain the site, or no perceived need for a separate departmental website. We then asked participants if they have felt pressure to increase web technology in the workplace, and if so, where that pressure came from. As shown in Figure 6, most respondents felt this pressure from “citizens” (73%), “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.

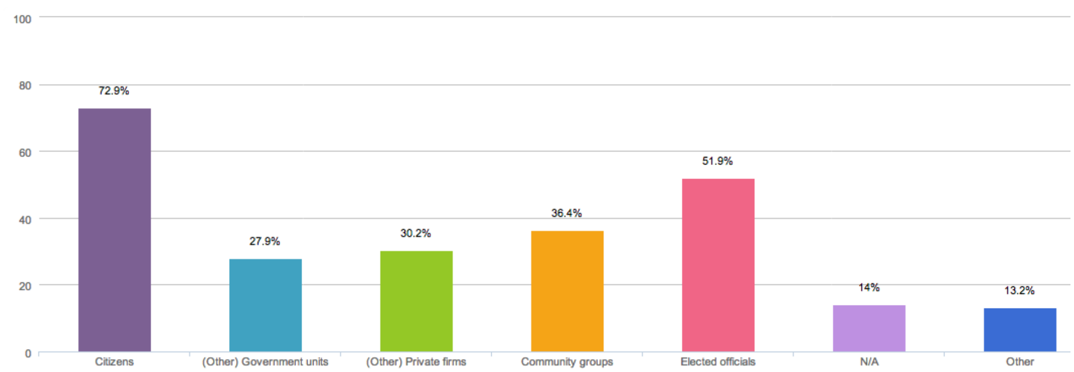


Figure 6. Pressure to increase web technology

Respondents were also asked about the interactions they performed through web technology and the types of software they used daily. Answer options were not mutually exclusive, and the most common responses include email (82%), search engine (73%), online forms (76%), job applications (65%), online audio/video streaming/live broadcasts (64%), and GIS/mapping (56%). The least common interactions using web technologies were filing for a variance (5%), purchasing copies of comprehensive plans (6%), virtual interaction (7%), and chat rooms/discussion forums (8%). Open-ended answers included an online library of projects and studies, real-time and static trip information, and a forum to report complaints or code violations (Figure 7).

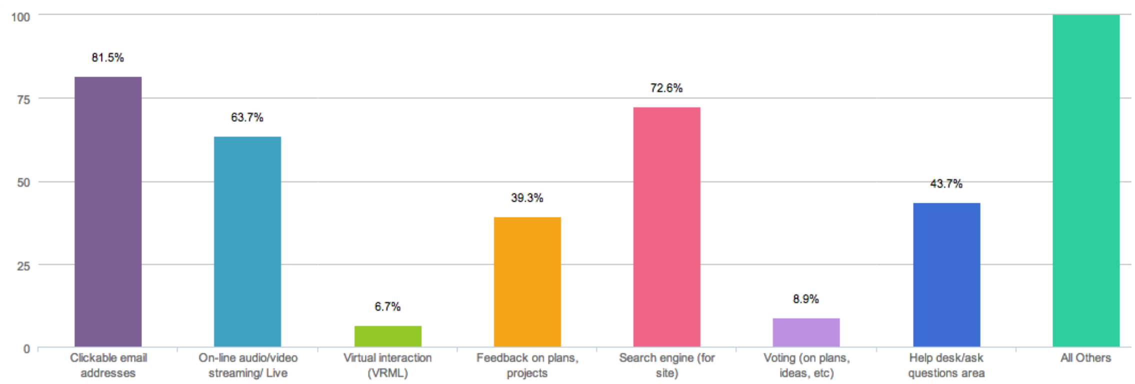


Figure 7. Interactions performed via web technology

Figure 8 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.

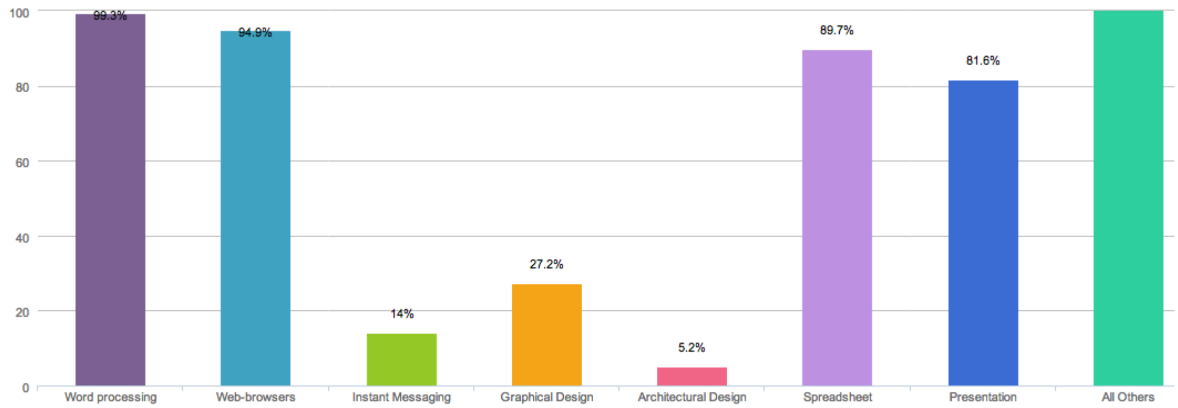


Figure 8. Commonly-used software applications

Mobile Profile

The following summary includes a description of the respondents' mobile use habits, especially in regards to the types of mobile applications they use for their professional work.

Of the professionals surveyed, 93% stated that they currently own a smart phone or tablet device, however, only 74% stated that they use their smart phone or tablet for work purposes. As shown in Figure 9, The majority of respondents who own a smart phone currently use the iOS platform (68%), followed by Android (24%), Windows (6%), and Blackberry (2%). A survey conducted by NetMarketShare resulted in similar ratios, with iOS comprising 51% of the total US Market share, Android having 38%, and Windows and Blackberry each with 1% (NETMARKETSHARE, 2014).

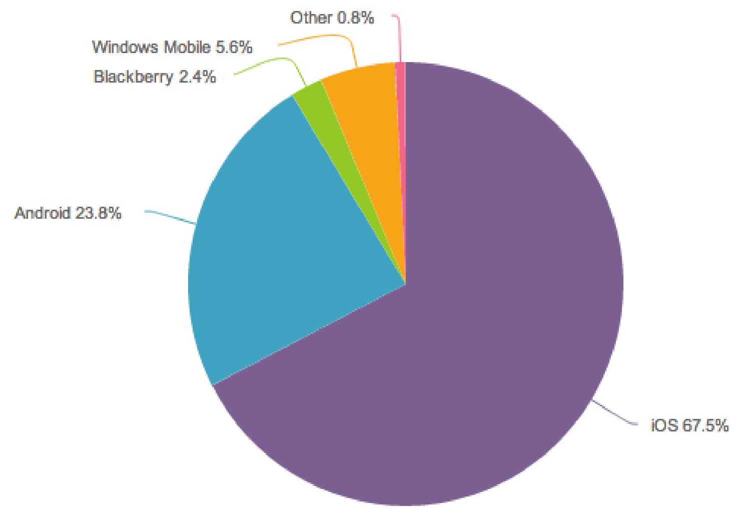


Figure 9. Mobile platform used

The remaining questions in the survey were filtered to display only for the 93% of respondents who stated that they currently own a smartphone or tablet (123 respondents). Questions focused on their agencies' dependency on mobile technology, barriers to using a smart phone for work purposes, types of interactions they complete via mobile technology, and types of applications they are currently using.

Overall, agencies were 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. 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%).

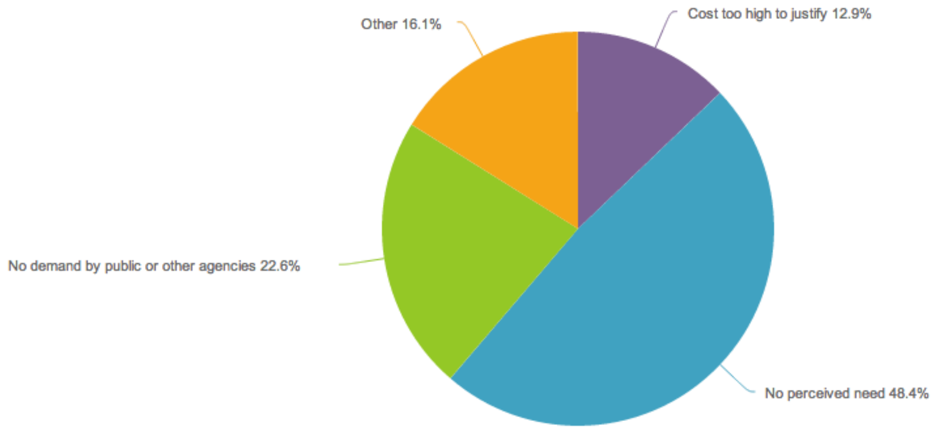


Figure 10. Reason for not using a smartphone for work purposes

The most common mobile software applications used by respondents differed slightly from web-based applications. As shown in Figure 11, 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.

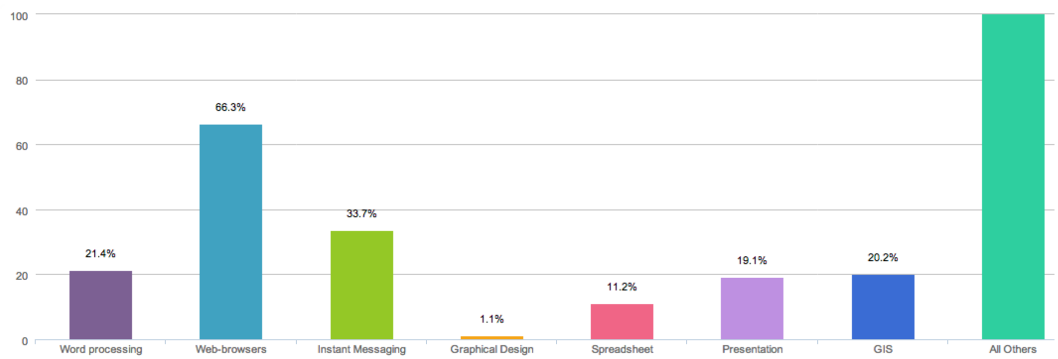


Figure 11. Mobile software used professionally

Respondents who currently own a smartphone were also asked about the type of interactions they complete via mobile devices or tablets. Similarly to general web technologies, Figure 12 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.

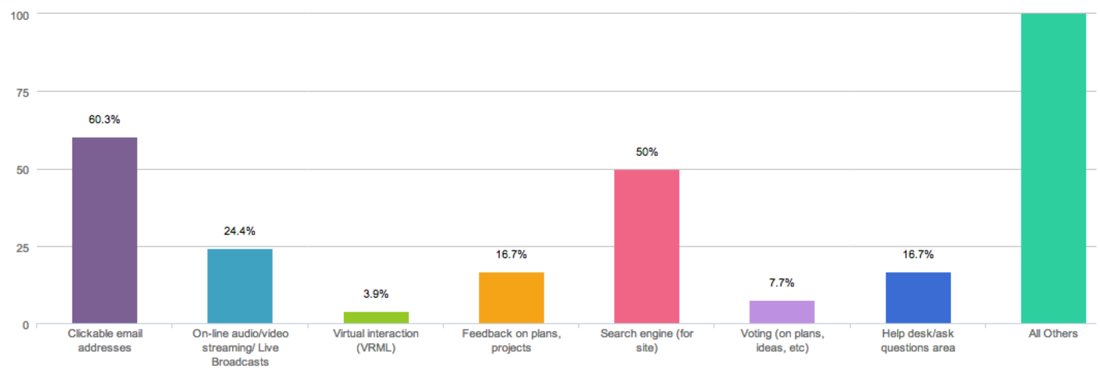


Figure 12. Interactions completed via mobile technology

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 that were 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

Future Application Development

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). 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.

Survey participants were also asked whether or not their agency has developed any mobile applications, and if not, if they had discussed creating one in the future. 85% of respondents stated that their organization has not developed any applications, and 25% of respondents said that their agencies had discussed creating one in the future (Figure 13).

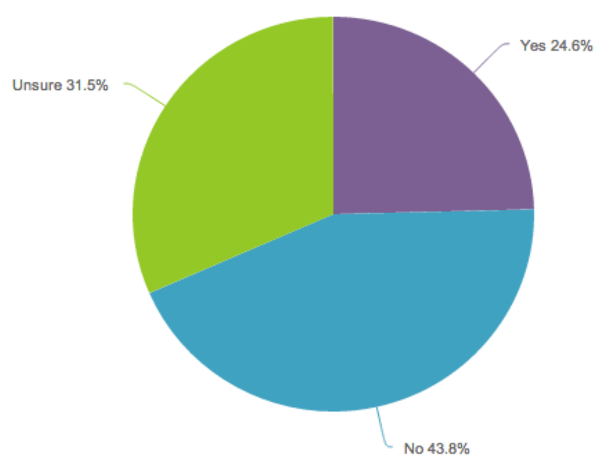


Figure 13. Plans for future application development

For those whose agencies had developed an application, responses included:

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

Barriers & Benefits

The most prevalent barriers to either using or developing applications to support their work 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 (Figure 14).

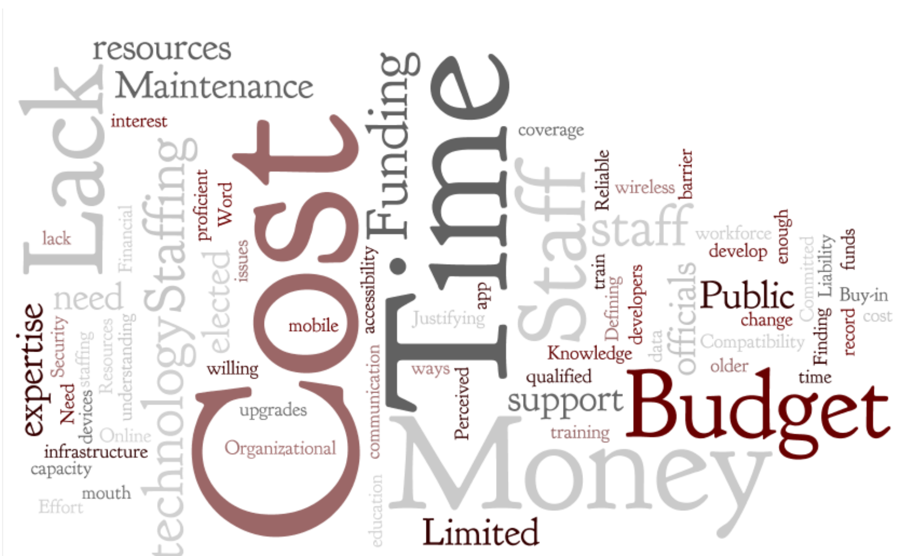


Figure 14. Barriers to application development

Finally, respondents were asked how their organization or agency would benefit from mobile applications that support their professional work (Figure 15). Responses included:

Figure 15. Benefits of mobile applications

Many respondents noted how mobile applications had the ability to improve community engagement processes, improve access to data, improve workplace efficiency and collaboration, streamline repetitive processes, disseminate important information more quickly and to a wider audience, and improve levels of customer service. These key words and functions were used to select 20 of the “most useful applications for planning professionals” from a comprehensive database, which is discussed in Chapter 5.

Statistical Summary

In order to further explain trends with mobile usage in the planning profession, and to get a sense of how trends based on organization and city, we broke the responses into cohorts. We organized the responses into eight different population cohorts based on city size: (1) 25,000 and below; (2) 25,001-50,000; (3) 50,001-75,000; (4) 75,001-

100,000; (5) 101,000-250,00; (6) 250,001-500,000; (7) 501,000-1,000,000; and (8) 1,001,000 and over. The graph below represents the distribution of respondents within each population cohort (Table 1).

Distribution of Population Sizes Served by Agency		
Cohort	**Number of Agencies in Cohort**	**% of Agencies in Cohort**
(1) Under 25K	40	34.2%
(2) 25-50K	15	12.8%
(3) 50-75K	17	14.5%
(4) 75-100	10	8.5%
(5) 100-250K	18	15.4%
(6) 250-500K	5	4.3%
(7) 500K-1M	4	3.4%
(8) +1M	8	6.8%

Table 1. Distribution of populations served by agency

These eight cohorts allowed for an understanding of various trends in mobile technology adoption varying by the independent variable of population size. The four dependent variables we tested against population size served by each agency were based off of the following four questions:

1. Does every staff member have access to a desktop computer or laptop?
2. How would you characterize your agency or organization’s dependence on internet technology?
3. Do you use your smart phone / tablet for work purposes?
4. How would you characterize your agency or organization's dependence on mobile technology?

Using a cross tabulation of data between each of the independent and dependent variables, it is notable that as the population size served by each planning agency increases, the percentage of agencies which provide every staff member a desktop computer or laptop remains fairly consistent from 80-100%. However, for agencies that serve a population of 500,000 or greater, access decreases slightly (Table 2). Although this discrepancy could be caused by sampling error, it may also be associated with a general lack of funding to provide every staff member with certain technological resources. Further testing is needed to make any assumptions about the causation of this decrease in access.

Population Size Served by Agency	% With access to a desktop computer or laptop
Under 25K	95.0%
25-50K	93.3%
50-75K	82.4%
75-100K	90.0%
100-250K	94.4%
250-500K	100.0%
500K-1M	75.0%
+1M	75.0%

Table 2. Access to a desktop computer or laptop

When we compared population size with each of the agency's dependence on *Internet* technology, most organizations, regardless of population size "could not operate without it," or are "very dependent." Only 2.5% of agencies which serve populations under 25,000 people "could easily function without" internet technology (Table 3). It is also interesting to note that although access to a computer or laptop slightly decreases for organizations in larger jurisdictions, dependency on internet technology increases.

Population Size Served by Agency	could not operate without it	very dependent	somewhat dependent	could easily function without it
Under 25K	35.0%	55.0%	7.5%	2.5%
25-50K	46.7%	46.7%	6.7%	0.0%
50-75K	35.3%	58.8%	5.9%	0.0%
75-100K	30.0%	50.0%	20.0%	0.0%
100-250K	44.4%	44.4%	11.1%	0.0%
250-500K	60.0%	20.0%	20.0%	0.0%
500K-1M	50.0%	50.0%	0.0%	0.0%
+1M	62.5%	25.0%	12.5%	0.0%

Table 3. Dependence on internet technology

When we compared population size with dependence on *mobile* technology, responses varied greatly. Responses for agencies that served populations of 75,000 and under remained fairly evenly distributed, while those who serve populations 75,000 and over were mainly "very dependent" or "somewhat dependent" (Table 4).

Population Size Served by Agency	could not operate without it	very dependent	somewhat dependent	not very dependent	could easily function without it
Under 25K	5.0%	30.0%	27.5%	27.5%	10.0%
25-50K	0.0%	26.7%	26.7%	33.3%	13.3%
50-75K	12.5%	18.8%	31.3%	25.0%	12.5%
75-100	0.0%	33.3%	11.1%	33.3%	22.2%
100-250K	5.6%	38.9%	38.9%	11.1%	5.6%
250-500K	20.0%	80.0%	0.0%	0.0%	0.0%
500K-1M	25.0%	0.0%	50.0%	25.0%	0.0%
+1M	12.5%	12.5%	50.0%	25.0%	0.0%

Table 4. Dependence on mobile technology

When we compared population size with the respondent's use of a smart phone or tablet for work purposes, we found that as the population served by the agency increases, so does the amount of professionals who use their smart phone for work purposes. However, two irregularities occurred for populations of 250-500,000 people, or over one million (Figure 20). This could due to the irregular distribution of data, since there were very few responses for planners who worked in agencies that served over 250,000 people.

Population Size Served by Agency	% of respondents who use smartphone/tablet for work purposes
Under 25K	70.3%
25-50K	64.3%
50-75K	70.6%
75-100K	80.0%
100-250K	88.2%
250-500K	60.0%
500K-1M	100.0%
+1M	57.1%

Table 5. Smartphone/tablet use for work purposes

In order to address this distribution inconsistency, and to verify these results, the same cross tabulations were calculated with a simpler distribution of cohort data. For the second level of analysis, two population cohorts were used: 75,000 and under, or over 75,000. 75,000 was used as a break point since it was the natural mid-point of the data distribution.

For the new population cohorts, approximately 90% of agencies that serve in both small and large jurisdictions provided every staff member with a desktop computer or laptop, which was consistent with prior findings (Figure 16).

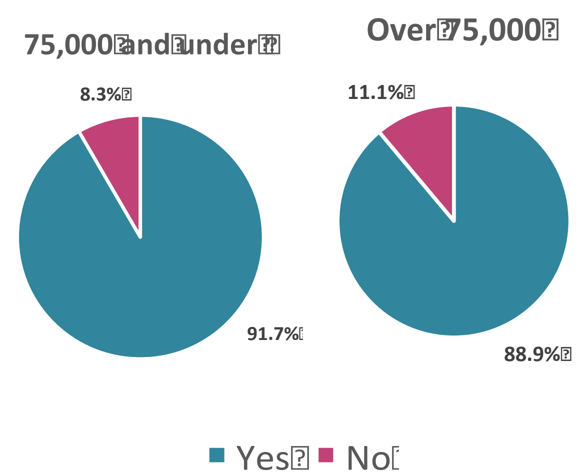


Figure 16. Access to a desktop computer or laptop by population cohorts (2)

When comparing the new population cohorts with each of the agency's dependence on *internet* technology, there was a slight increase for agencies in larger jurisdictions who "could not operate without it." The majority of agencies in smaller jurisdictions stated that they are "very dependent" on internet technology (Figure 17). This data also remains consistent with previous findings.

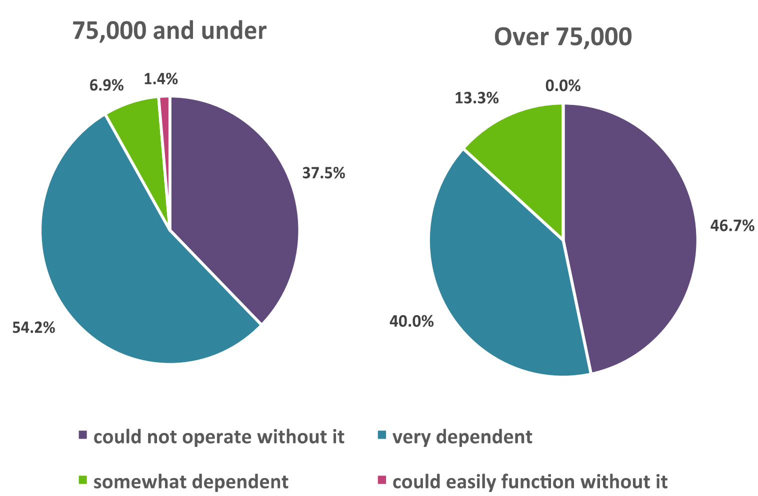


Figure 17. Dependence on internet technology by population cohorts (2)

Our findings varied slightly when we compared population size with dependence on *mobile* technology with the redistribution of data. 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 (Figure 18).

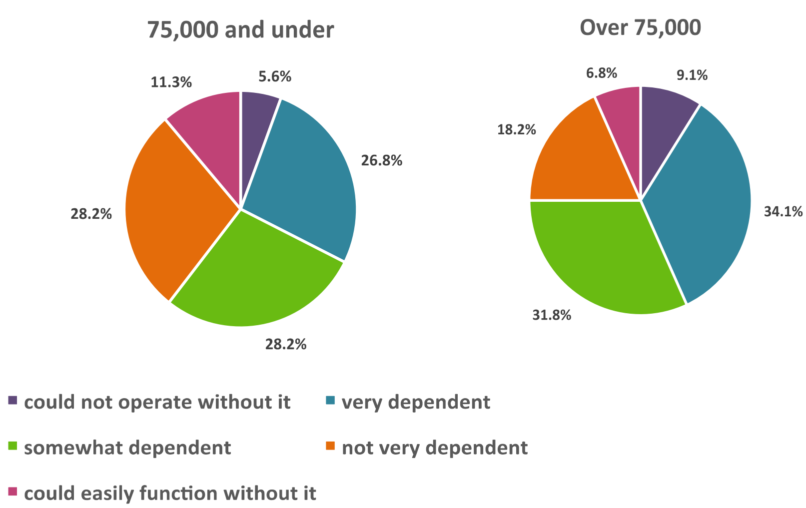


Figure 18. Dependence on mobile technology by population cohorts (2)

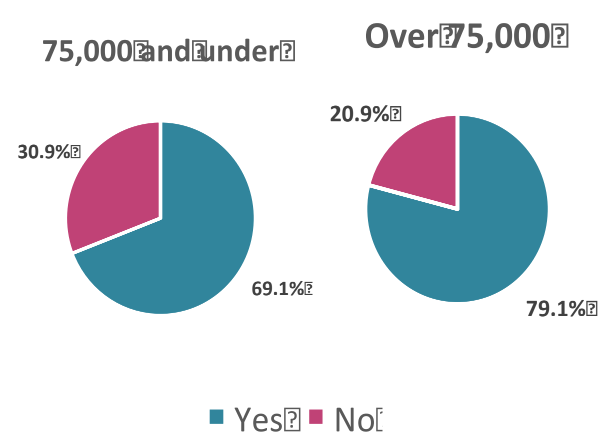


Figure 19. Smartphone/tablet use for work purposes by cohort (2)

When comparing population size with the respondent's use of a smart phone or tablet for work purposes, about 10% more respondents who worked in larger jurisdictions stated that they used their smart phone or tablet for work purposes (Figure 24). This redistribution of data helped smooth out the irregularities caused by the previous cohorts. 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, and social factors could influence trends in technology adoption. Further research should be conducted on the influence of these factors on the mobile and web technology use in the professional planning practice.

CHAPTER FIVE: APPLICATION DATABASE AND TAXONOMY FINDINGS

Application Database

From November of 2013 until April of 2014 we compiled a database of mobile applications that are associated with the planning profession. The search utilized keywords found in the survey, which included the terms: “urban planning, planning, city planning, community engagement, civic engagement, and public input.” Application data was gathered using mainly a basic web search, but also through discussions in academic papers focused on various topics associated with mobile technology and urban planning. In total, we collected and categorized a total of 132 applications. As shown in Chapter 4, there may be untapped potential to integrate mobile technology in professional planning activities, especially in smaller communities that are often limited by budget and time constraints. The creation of this database and its corresponding taxonomy will prove useful for planning agencies to determine which types of applications are currently available to them, and how they could use those technologies to streamline and improve various professional activities.

Information collected for each application included the following variables: 1) application name, 2) primary category, 3) subcategory, 4) platform(s) it is offered on, 5) A brief description, 6) web link for its purchase and/or description, 7) price, and 8) developer. The primary and secondary category for each application was established at a later time using the taxonomy system discussed in the following section.

Taxonomy

Research conducted by Nickerson et al. (2009) provides a detailed description for developing a new taxonomy of mobile applications, and demonstrates "how a mobile app taxonomy can be used to analyze current and future applications" (p. 2). In their report, they propose that a useful taxonomy has the following desirable attributes:

- It should be **concise**. It should contain a limited number of characteristics in each dimension, because an extensive classification scheme with many dimensions and many characteristics would be difficult to comprehend and difficult to apply.
- It should be **sufficiently inclusive**. It should contain enough dimensions and characteristics to be of interest.
- It should be **comprehensive**. It should provide classification of all current objects within the domain under consideration.
- It should be **extendible**. It should allow for additional dimensions and new characteristics within a dimension when new types of objects appear.

The first consideration to be made when developing a taxonomy is to determine the "meta-characteristic" that will serve as a basis for the classification. For this study, we are interested in the specific *use* of mobile applications, and not in their hardware or software characteristics that set them apart. Our purpose of developing taxonomy is to determine the capability of each application to support professional planning activities, and therefore we distinguished among the applications based on the manner in which planners interact with the application. Therefore, the meta-characteristic for developing our taxonomy is the interaction between the planner and the mobile application.

After collecting a list of mobile applications in a comprehensive database, we used an empirical to deductive approach to determine user interaction characteristics of the various applications. In the Nickerson et al. study (2009), their 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 identified 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 6. 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 the initial five dimensions were established, we utilized a deductive to empirical approach to include “additional conceptualizations that might not have been identified or even present in the original empirical data,” which fit into existing dimensions. (Nickerson et al., 2009). These “additional conceptualizations” were established as 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 below:

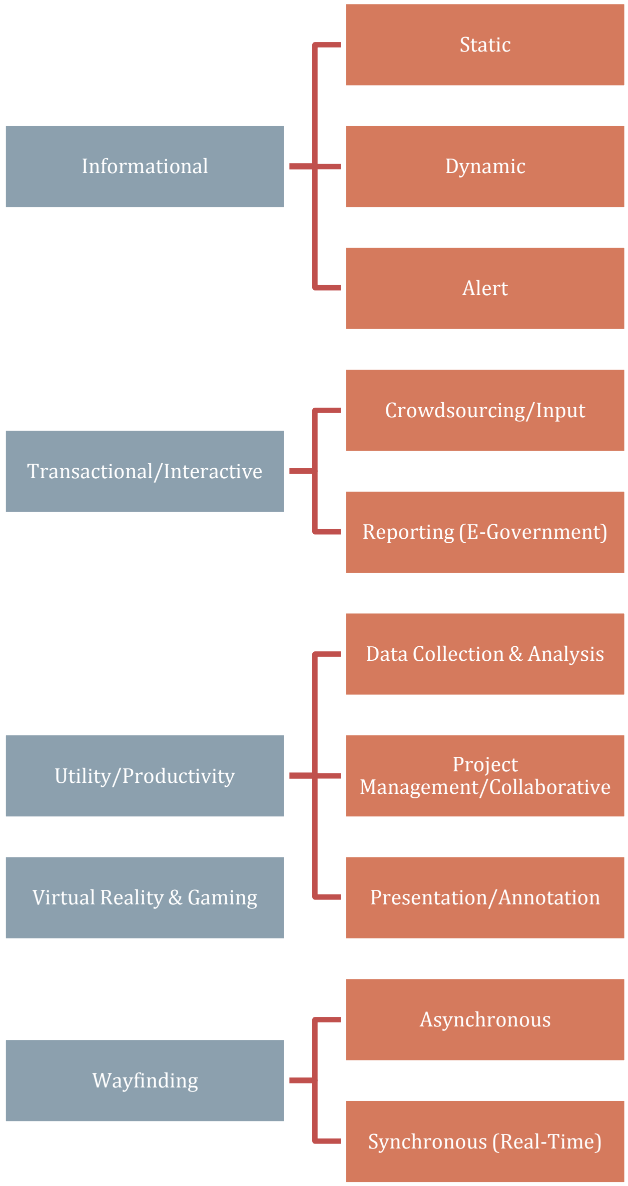


Figure 20. Final taxonomy

Application Selection

Based on survey responses on how agencies would benefit from mobile applications that support their professional work, we selected the “top 20” mobile applications for planners from a comprehensive database. Most of our respondents noted how mobile applications had the ability to improve community engagement processes, improve access to data, improve workplace efficiency and collaboration, streamline repetitive processes, disseminate important information more quickly and to a wider audience, and improve levels of customer service.

From these responses, we selected the “top 20” mobile applications for planning professionals from the database of applications using the following criteria:

1. Having had mentioned the application in the survey.
2. Having the “planner” as the primary user or receiver of information from the application, as opposed to any other professional user or citizen.
3. Specific relevance to the planning profession or a planning-related activity.
4. Availability in different locations.
5. Availability across a variety of mobile platforms (e.g. iOS, Android, etc.)
6. Recent software updates/availability of up-to-date information.

A detailed description of the selected applications is presented below.

Application Descriptions

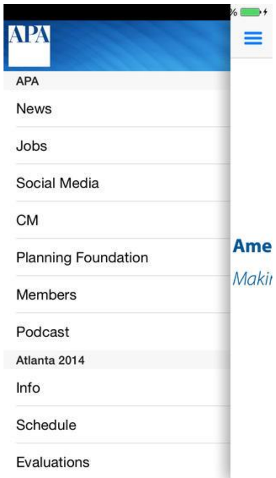
American Planning Association App

Category: Informational-Static
Cost: Free
Developer: American Planning Association
Website: https://itunes.apple.com/us/app/american-planning-association/id514114782?mt=8
Available for: Android/ iOS

Description:

The APA app allows planning professionals across the world to read daily planning news, check open positions, view customized schedules for the National Planning Conference, connect with friends and colleagues, and track their professional progress by searching AICP CM-eligible educational events and recording earned credits.

Screenshots:

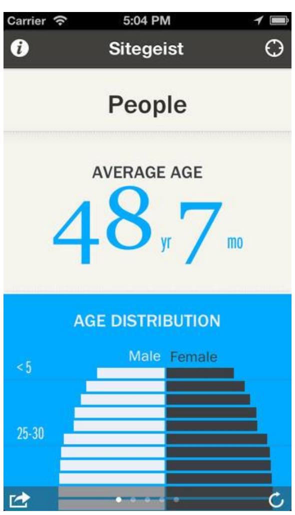


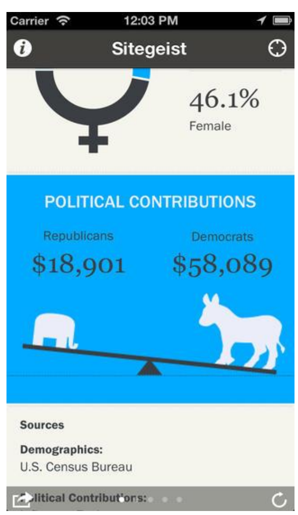
Sitegeist
Category: Informational-Dynamic
Cost: Free
Developer: Sunlight Foundation
Website: http://sitegeist.sunlightfoundation.com/
Available for: Android/ iOS

Description:

Sitegeist draws on publicly available localized information for a variety of topics, including demographics and housing, to present data in a simple format in a location anywhere in the United States.

Screenshots:





ESRI Business Analyst Online
Category: Informational-Dynamic
Cost: Free trial/subscription
Developer: ESRI
Website: http://www.esri.com/software/bao-for-smartphones-tablets
Available for: Android/ iOS

Description:

Allows users to access key demographic and market facts about any location of the US using your Smartphone or tablet. The applications gives you demographic and market information including location, age, income, education and consumer spending, lets you compare the demographic and market data between two locations, lets you scope out competition or locations of businesses, and set desired criteria to see how a location matches with a business.

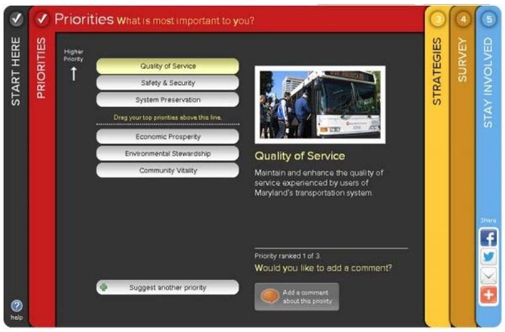
Screenshots:

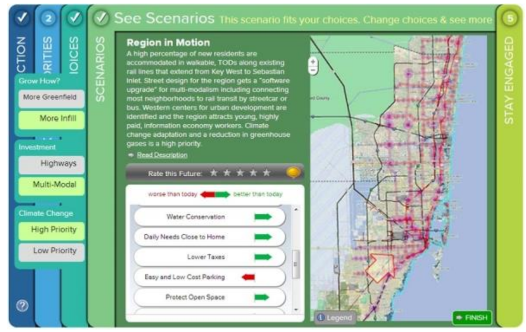
MetroQuest
Category: Interactive-Crowdsourcing/Input
Cost: Subscription
Developer: Envision Sustainability Tools Inc.,
Website: http://metroquest.com/
Available for: iOS (iPad only)

Description:

This application is part of an online community engagement platform for planning projects. MetroQuest software enables the public to learn about your project and provide meaningful feedback using a variety of fun and visual screens. Each configuration is comprised of a series of 4 to 5 screens which guide participants through the process of learning about the project and providing input, and can vary to suit the engagement needs of different projects.

Screenshots:



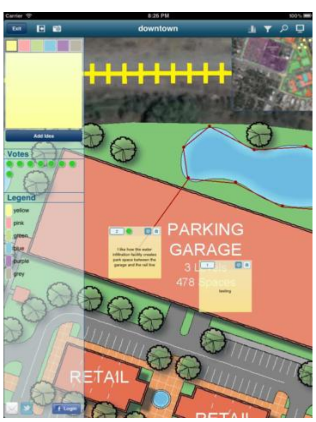


Crowdbrite
Category: Interactive-Crowdsourcing/Input
Cost: Free Trial/Varied Plan
Developer: Crowdbrite
Website: http://www.crowdbrite.com/
Available for: iOS (iPad only)

Description:

Crowdbrite mobile allows project coordinators to invite team members, outside professionals/experts and the community to collaborate on projects. The mobile platform allows access to projects loaded on crowdbrite web, collect, comment, and rank ideas and make better informed decisions. Members can interact in real-time to contribute ideas, cast votes, host live meetings, receive instant project updates, and accelerate critical decisions.

Screenshots:



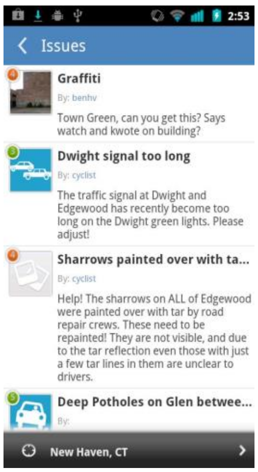
SeeClickFix
Category: Interactive-Reporting
Cost: Free
Developer: SeeClickFix

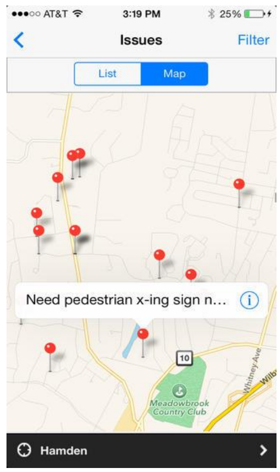
Website: http://en.seeclickfix.com/
Available for: Android/iOS/Windows//Blackberry

Description:

SeeClickFix encourages residents to become citizens by reporting and mapping issues they see on the street with detailed descriptions, photos, and videos. Users can report and map issues from anywhere, alert relevant community members or government officials, and comment on issues that other users have reported.

Screenshots:



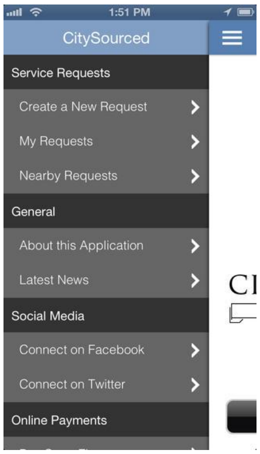


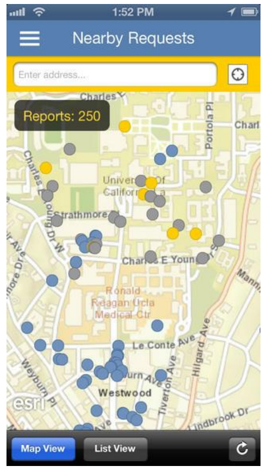
CitySourced
Category: Interactive-Reporting
Cost: Free
Developer: CitySourced,Inc.
Website: https://www.citysourced.com/default.aspx
Available for: Android/iOS/Windows//Blackberry

Description:

CitySourced is an enterprise mobile civic engagement platform that allows citizens and residents to quickly identify and report issues effecting their communities and quality of life, including potholes, graffiti, broken street lights, public safety, environmental, and other concerns.

Screenshots:





US Green Infrastructure
Category: Interactive-Reporting
Cost: Free
Developer: Yanfu Zhou
Website: https://itunes.apple.com/us/app/u.s.-green-infrastructure/id649494003?mt=8
Available for: iOS

Description:

U.S. Green Infrastructure reporter allows for grassroots reporting for green infrastructure initiatives, such as rain barrels, rain gardens, green roofs, green infrastructure industries, and so on.

Screenshots:

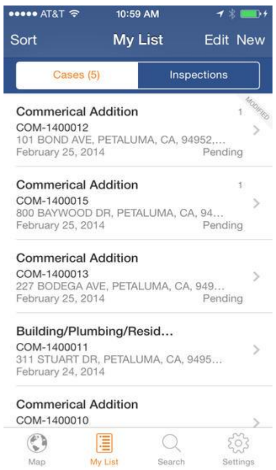
Accela Code Officer
Category: Interactive-Reporting
Cost: Subscription
Developer: Accela

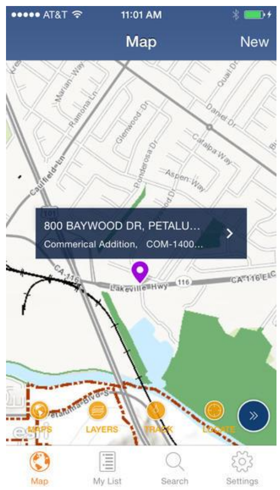
Website: http://www.accela.com/civic-apps?id=517
Available for: iOS

Description:

Accela Code Officer allows Code Enforcement Officers to do their jobs more efficiently while working in the field with their smartphone or tablet. Integrated with Accela Automation, Accela Code Officer enables Officers to view locations of cases on a map containing agency-defined map layers, perform sweeps and trace the paths on the map, create cases right from the app, view assigned cases, search for cases and inspections and add them to a list, and save searches for easy access.

Screenshots:





Traffic Duco
Category: Utility/Productivity-Data Collection & Analysis
Cost: Subscription
Developer: Traffic Duco, Inc.
Website: http://www.trafficduco.com/
Available for: iOS

Description:

Traffic Duco facilitates auditable traffic data collection for professional traffic engineers and planners. The integration of web service and the mobile applications provide a complete and auditable solution for traffic data collection, reporting, warehousing and information exchange.

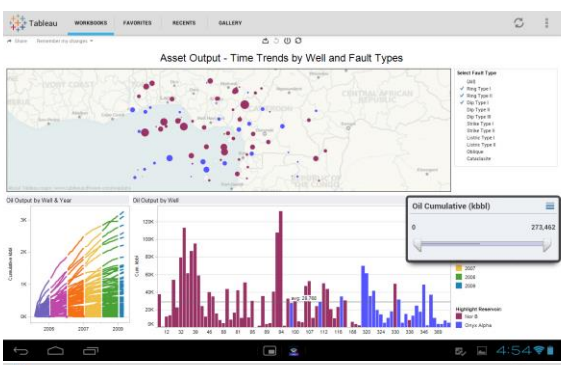
Screenshots:

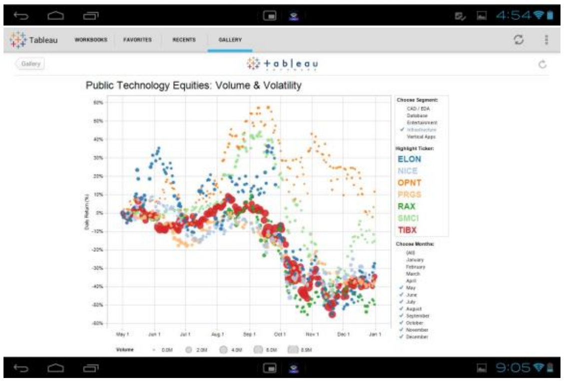
Tableau Mobile
Category: Utility/Productivity-Data Collection & Analysis
Cost: Subscription
Developer: Tableau Software
Website: http://www.tableausoftware.com/
Available for: Android/iOS (iPad only)

Description:

Tableau Mobile is a data visualization software that displays rich visual analytics that display faster and more flexible than older solutions. Users can create interactive reports and dashboards and then publish them to the Tableau Server for secure access on a desktop, on the web, or with an iPad.

Screenshots:



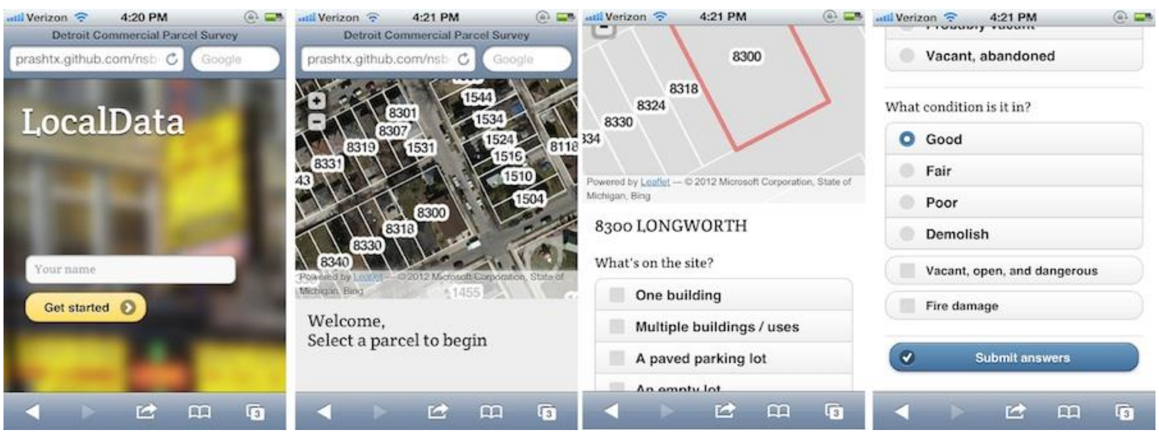


LocalData
Category: Utility/Productivity-Data Collection & Analysis
Cost: Free
Developer: Code for America
Website: http://localdata.com/about
Available for: iOS

Description:

LocalData is a digital toolkit that allows organizers and canvassers to collect and manage place-based data. Users can use their smartphones or tablets to collect data in the field, and runs on a mobile browser (no separate application to download). Organizers can build custom surveys designed to fit specific neighborhood needs.

Screenshots:

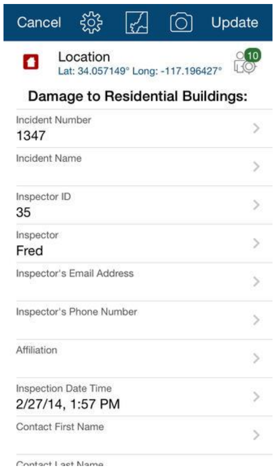


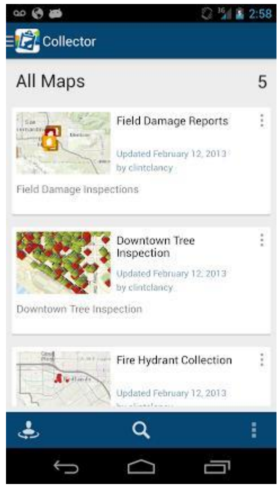
Collector for ArcGIS
Category: Utility/Productivity-Data Collection & Analysis
Cost: Free trial/ Paid subscription
Developer: ESRI
Website: http://www.esri.com/software/arcgis/arcgisonline/apps/collector
Available for: Android/iOS

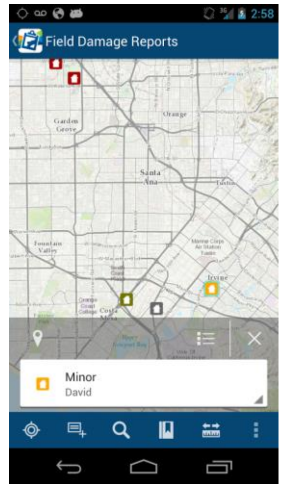
Description:

Collector for ArcGIS allows users to collect and update damage information (reports, service requests, places of historical interest, etc.) in the field, whether connected or disconnected. Users can share captured photos and videos along with the data and configure the app to fit their organization's workflow.

Screenshots:





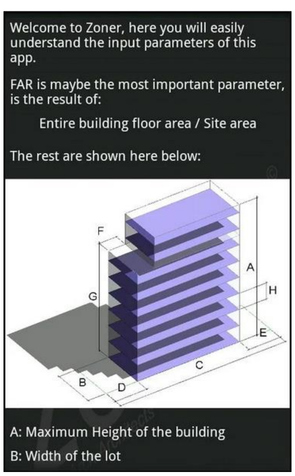


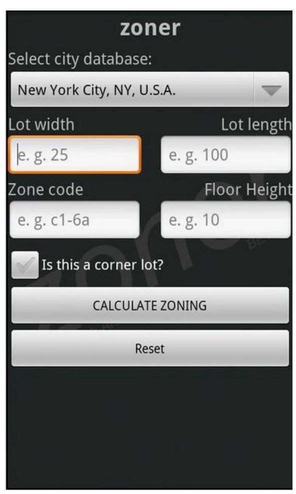
Zoner
Category: Utility/Productivity-Data Collection & Analysis
Cost: Free
Developer: SOLER-MARCH Technologies
Website: https://play.google.com/store/apps/details?id=com.masr.zoner
Available for: Android

Description:

Gives users the ability to calculate the maximum buildable floor area for a specific property in seconds. Currently the app uses the Zoning Resolution of New York City, NY.

Screenshots:





Energov Mobile Suite
Category: Interactive-Reporting
Cost: Free

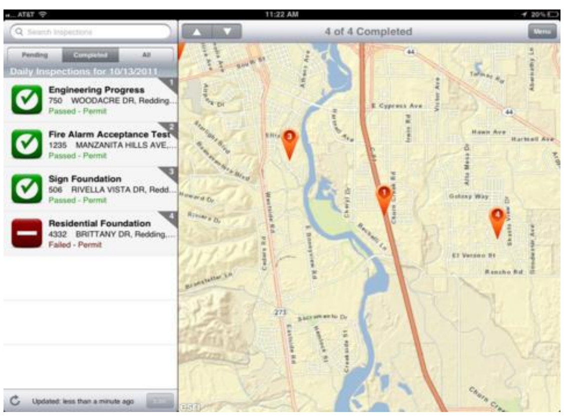
Developer: iG Workforce
Website: http://www.tylertech.com/solutions-products/energov-product-suite/mobile-applications
Available for: iOS (iPad) and some Windows

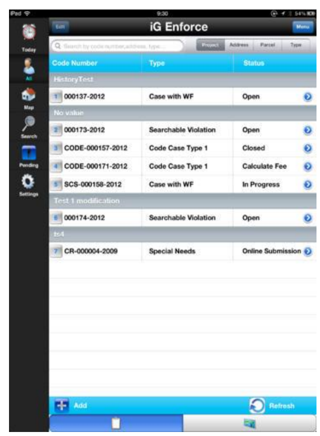
Description:

The EnerGov Mobile Application Suite is a comprehensive mobile workforce platform which empowers government workers to manage cases, code enforcement, inspections and the plan review process in the field. The Suite includes:

- **iG Enforce App**: users can complete enforcement management tasks in real time to streamline the code enforcement process.
- **iG Inspect App**: users can easily manage inspections for buildings, land use, environmental, health, safety and compliance.
- **iG Reviews App**: users can make recommendations or corrections, view digital plans r collaborate with other parties.
- **iG Works (coming soon)**: allows users to track resources, equipment and inventory related to work orders.

Screenshots:



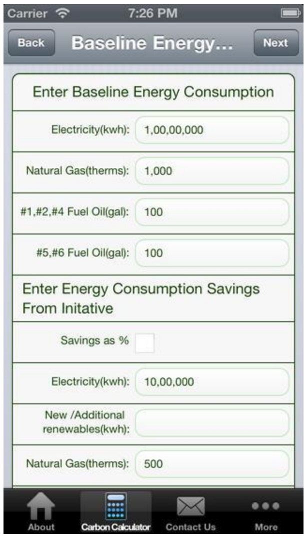


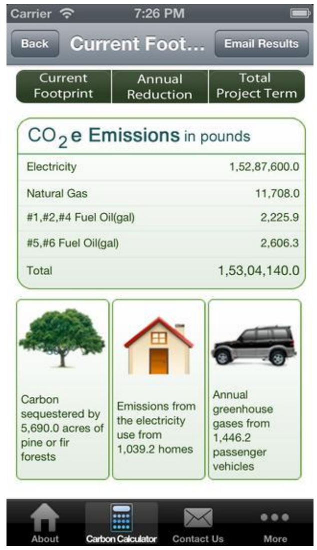
Environmental Impact Calculator
Category: Utility/Productivity-Data Collection & Analysis
Cost: Free
Developer: Siemens AG
Website: http://www.apptology.com/portfolio/apple/environmental-impact-calculator.html
Available for: Android/iOS

Description:

This app allows you to estimate your building's baseline carbon footprint from purchased electricity, natural gas, and heating oil. The app also allows users to measure the impact of energy efficiency improvements on an annual basis or throughout the length of a project term.

Screenshots:



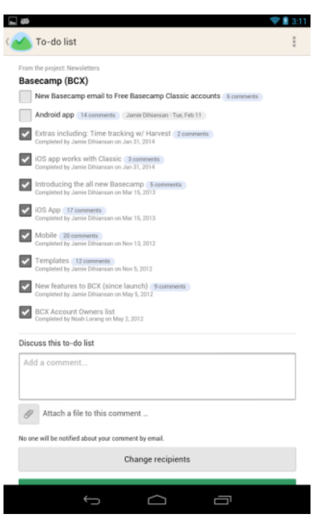


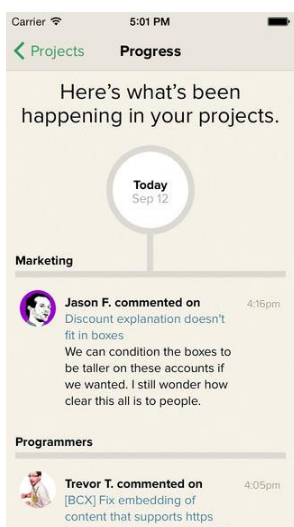
Basecamp
Category: Utility/Productivity-Project Management/Collaborative
Cost: Free trial/ Monthly& Annual subscriptions
Developer: Basecamp, LLC
Website: https://basecamp.com/
Available for: Android/iOS

Description:

Basecamp is a project management application which allows project team members to read messages, post comments, complete to-dos, see and set milestones, browse Writeboard discussions, view team progress, upload project files, and see updated news for each project.

Screenshots:



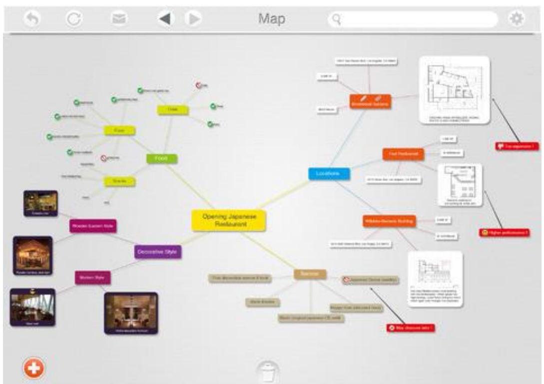


MASTERPlan.IT
Category: Utility/Productivity-Project Management/Collaborative
Cost: Free
Developer: Payal Shah
Website: https://itunes.apple.com/us/app/masterplan.it/id703327306?mt=8
Available for: iOS (iPad)

Description:

MasterPlan.IT is a mind map building application for project teams to help team members communicate, collaborate, organize and track work.

Screenshots:

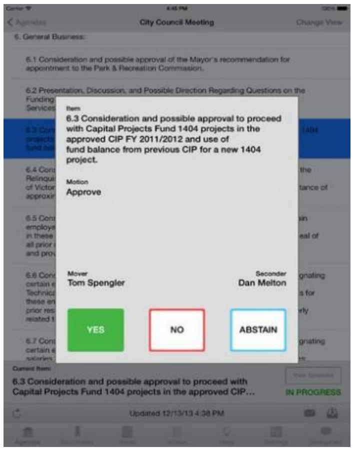


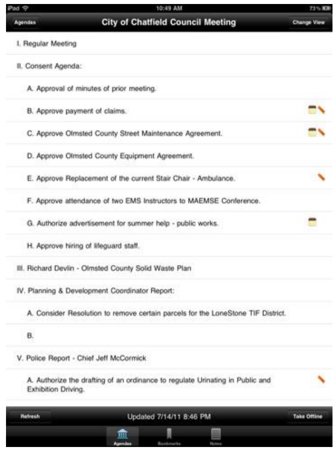
iLegislate
Category: Utility/Productivity-Presentation/Annotation
Cost: Free
Developer: Granicus
Website: http://www.granicus.com/products/ilegislate-mobile-agenda-ipad-app/
Available for: iOS (iPad)

Description:

iLegislate enables governments to review meeting agendas, supporting documents, and archived videos over the iPad. The app allows government officials to eliminate time and material costs by introducing a completely paperless environment for agendas. The app also seamlessly connects all agenda data to the iPad, and automatically updates it with the latest information when online, and is available for review when offline.

Screenshots:



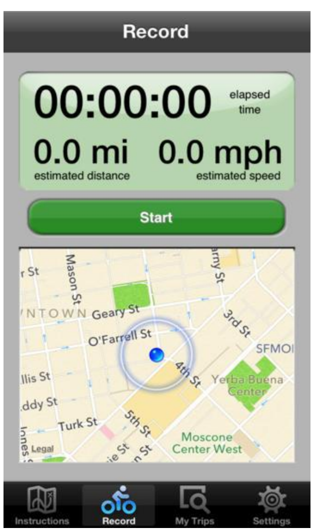


CycleTracks
Category: Wayfinding-Synchronous
Cost: Free
Developer: San Francisco County Transportation Authority
Website: http://www.sfcta.org/modeling-and-travel-forecasting/cycletracks-iphone-and-android
Available for: Android/iOS

Description:

CycleTracks uses GPS support to track users' bicycle trip routes. City transportation authority's can collect data on user's route, time and date, direction, and purpose while keeping all personally identifiable data confidential.

Screenshots:



CHAPTER SIX: IMPLICATIONS AND CONCLUSION

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.

BIBLIOGRAPHY

Ahas, R., & Ular, M. (2005). Location based services - new challenges for planning and public administration?.Futures, 37(6), 547.

Alshuwaikhat, H., & Nkwenti, D. (2003). *Collaborative planning and management frameworks: Approaches to effective urban governance by adoption of emerging technologies.* International Journal of Management, 20(3), 294-305. Retrieved from http://faculty.usfsp.edu/gkearns/Articles2/Collaborative planning and management framework.pdf.

Badger, Emily. (November 2, 2011). Urban Planning in the iPhone Age" Citylab. Retrieved from http://www.citylab.com/tech/2011/11/iphone-apps-urban-planners/413/.

Bassett, C. 2005. *How many movements? Mobile telephones and transformations in urban space*. Open 9:38-47.

Calabrese, F., K. Kloeckl, and C. Ratti. 2009. WikiCity: Real-time location-sensitive tools for the city. In Handbook on research on urban informatics: The practice and promise of the real-time city, ed. M. Foth, 390-413. London: IGI Global.

Carrel, A., Ekambaram, V., Gaker, D., Jariyasunant, J., Sengupta, R., & Walker, J. L. (2012). *The Quantified Traveler: Changing transport behavior with personalized travel data feedback*. Retrieved from www.uctc.net/research/papers/UCTC-FR-2012-12.pdf

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Sage Publications, Inc.

CTIA. Year-End 2012 Semi-Annual Wireless Industry Survey. (2013, May 2). Retrieved from http://blog.ctia.org/2013/05/02/semi-annual-survey/

Cuff, D. , Hansen, M. , & Kang, J. (2008). *Urban sensing: Out of the woods. Association for Computing Machinery.* Communications of the ACM, 51(3), 24.

Decker, John. (1993). *Simulation methodologies for observing large-scale urban structures. Landscape and Urban Planning*. 26: 231-50.

Duggan, Maeve., Smith, Aaron. "Social Media Update 2013." Pew Research Center, Washington, D.C. (December 30, 2013) http://www.pewinternet.org/files/2013/12/PIP_Social-Networking-2013.pdf, accessed April 10, 2014.

Dunn, C. E. (2007). Participatory GIS—a people's GIS?. *Progress in human geography*, *31*(5), 616-637.

Evans-Cowley, J., & Kubinski, Brittany. (September 4, 2012). *A Brave New World: How Apps Are Changing Planning.* Planetizen. Retrieved from http://www.planetizen.com/node/58314

Evans-Cowley, J., Kitchen, J. (2011) *E-Government*. American Planning Association (Planners Press).

Evans-Cowley, J. (2010). *Planning in the real-time city: the future of mobile technology.* Journal of Planning Literature, 25(2), 136-149.

Foth, M., Bajracharya, B., Brown, R., & Hearn, G. (2009). *The Second Life of urban planning? Using NeoGeography tools for community engagement*. Journal of Location Based Services, 3(2), 97. doi: 10.1080/17489720903150016

Fowler, F. J. (2013). *Survey research methods* (Vol. 1). Sage.

Gordon, E., & Koo, G. (2008). *Placeworlds: Using virtual worlds to foster civic engagement. Space and Culture,* 11(3), 204-221.

Gergen, K. J. 2000. *The saturated self: Dilemmas of identity in contemporary life*. New York: Basic Books.

Goggin, G. , & Clark, J. (2009). *Mobile phones and community development: A contact zone between media and citizenship*. Development in Practice, 19(4/5), 585-597.

Goodchild, M., & Sui, D. (2011). *The convergence of GIS and social media: challenges for GIScience.* International Journal of Geographical Information Science.

Governor's Office of Planning and Research. (2012). *Directory of California Planning Agencies* [Data file]. Retrieved from http://www.opr.ca.gov/docs/2012DOPA.pdf

Hall, E. T. 1966*. The hidden dimension. New York*: Anchor Books.

Hampton, K. N. (2003*). Grieving for a lost network: collective action in a wired suburb special issue: ICTs and community networking*. The Information Society, 19(5), 417-428.

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

Harkin, James. 2003. Life lines. New Statesman, September 15, 17: 774, R3-R5.

Harris, Britton. (1996). *Planning Technologies and Planning Theories.* Explorations in Planning Theory .Center for Urban Policy Research, Rutgers, The State University of New Jersey. 483-96.

Kaiser, E. J., & Godschalk, D. R. (1995). *Twentieth century land use planning: A stalwart family tree*. Journal of the American Planning Association, 61(3), 365-385.

Katz, J. E. 1996. *The social consequences of wireless communications.* In The emerging world of wireless communications, 91-199. Annual Review of the Institute for Information Studies. Nashville, TN: Institute for Information Studies.———. 1998. The social side of information networking. Society 35:402.

Kwak, H., Lee, C., Park, H., & Moon, S., (2010). *What is Twitter, a social network or a news media?* In Proceedings of the 19th international conference on World Wide Web (591-600). ACM.

Lindholm, M., & Sarjakoski, T. (1992). *User models and information theory in the design of a query interface for gis. Theories and Methods of Spatio-Temporal* …. Retrieved from http://link.springer.com/chapter/10.1007/3-540-55966-3_20

Ling, R. 2004. *The mobile connection: The cell phone's impact on society. San Francisco, CA*: Morgan Kaufmann Publishers.

Mitchell, W. J. (2000). *E-topia: "Urban life, Jim--but not as we know it".* The MIT Press.

NETMARKETSHARE. (2014). Mobile/Tablet Operating System Market Share. Market Share Statistics for Internet Technologies. Retrieved from http://www.netmarketshare.com/operating-system-market-share.aspx?qprid=8&qpcustomd=1

Nickerson, R., Muntermann, J., Varshney, U., & Isaac, H. (2009). *Taxonomy development in information systems: Developing a taxonomy of mobile applications*. European Conference in Information Systems.

Pitkin, B. (2001). *A historical perspective of technology and planning*. Berkeley Planning Journal, 15, 32-55.

Ratti, C., Williams, S., Frenchman, D., & Pulselli, R. M. (2006). *Mobile landscapes: using location data from cell phones for urban analysis.* Environment and Planning & Planning and Design, 33(5), 727.

Ray, A. P. (2011). Planning Connected: Using Online Social Networks to Improve Knowledge about Places and Communities.

Simpson, D. M. (2001*). Virtual Reality and Urban Simulation in Planning: A Literature Review and Topical Bibliography*. Journal of Planning Literature.

Townsend, A. (2000). *Life in the real-time city: Mobile telephones and urban metabolism.* Journal of Urban Technology, 7(2), 85-104.

Zurita, G., & Baloian, N. (2012). *Mobile, Collaborative Situated Knowledge Creation for Urban Planning.* Sensors.

Zube, E. H., & Simcox, D. E. (1993). *Landscape Simulation*. Environmental Simulation (pp. 253-278). Springer US.