

A Proposed Structure for Understanding Interactive City Tools

Andrew Nash

May 2, 2013

andy@andynash.com

andynash.com

Abstract

Interactive city tools can help cities succeed in an era of constrained finances and growing needs. Interactive tools are technologies and social applications that enable city residents to help provide services formerly provided by the city alone. They extend traditional public participation from the planning process to the process of actively helping make the city better. This paper presents a framework for categorizing interactive city tools. The framework consists of five main elements: input, analysis, support, collaboration and output. The framework was developed to help better understand the relationships between elements and to help identify missing elements or new ways of combining elements to help point the way for new interactive tools. The structure is a work in progress and will surely grow and change. The paper presents example interactive tools and some general conclusions drawn from the process of developing the structure.

1. Introduction

This paper presents a framework for categorizing applications designed to help people actively participate in improving their cities. The applications are generally available on the Internet and fall loosely into the category of social media. In this paper they will be called interactive city tools¹ to reflect the fact that they allow people to interact with their city government. (1)

The paper begins by asking why cities need interactive tools and outlining how cities could work in the “social era”. Section 4 proposes a five-part structure for categorizing interactive tools: input, analysis, support, collaboration and output. Sections 5-9 describe each type of tool and provide examples mostly from transport and planning. Section 10 presents general conclusions.

2. Why do cities need interactive tools?

Cities are rapidly becoming the most important human institution. They have always been the most important driver of culture and intellectual thought, and are now being recognized as the most important driver of economic growth. While these points are staples of urban planning literature, they are now being confirmed as people vote with their feet and crowd into cities.

¹ Play the City uses the term “interactive city tool” in their research project Majority Report (Play the City, 2013) <http://www.playthecity.nl/12460/en/seven-keys-to-make-an-interactive-city-tool>

Cities are growing throughout the world. Headlines describe the extremely rapid growth of developing world cities. According to the World Health Organization:

Today, the number of urban residents is growing by nearly 60 million every year. ... By the middle of the 21st century, the urban population will almost double, increasing from approximately 3.4 billion in 2009 to 6.4 billion in 2050. ... (The urban population of developing countries will increase) from 2.5 billion in 2009 to almost 5.2 billion in 2050. ... In high-income countries, on the other hand, the urban population is expected to remain largely unchanged over the next two decades, increasing from 920 million people to just over 1 billion by 2025. In these countries, immigration (legal and illegal) will account for more than two-thirds of urban growth. (2)

Often, as in the quote above, urban population growth in high income cities is downplayed, but growth of 80 million people in 20-years (about 8%) can't be ignored by those planning and managing cities. This is especially true given the changing demographic conditions in high income cities (where populations are becoming older and growth is mostly from immigrants).

Population growth and changing demographics have both positive and negative impacts on cities. On the positive side, higher growth provides more workers and economic activity, changing demographics provides diversity and new ideas. On the negative side higher growth increases the need for all types of infrastructure and services. Demographic change means different types of infrastructure and services will be needed. Without sufficient high quality infrastructure and services cities will fail to achieve their economic goals and negatively impact the environment.

At the same time cities are facing these challenges, their actions are being constrained by financial and policy interventions from higher level governments. Financial interventions include tax redistribution favouring non-urban areas, limitations on the ability of cities to raise their own financial resources, and corruption, to name several. Policy interventions include influence or control by higher level governments on urban infrastructure and service distribution (e.g. controlling where metros or roadways are built). While higher level governments need to play a role in urban decisions, they often play too great a role.

The only way cities will be able to successfully meet these challenges is if they are able to motivate their residents to support new infrastructure and services based on innovative new strategies. They, like cities in the past, must create a compelling vision and an agreed-upon public agenda to make these plans and accompanying public investment possible. (3)

These subjects are discussed extensively in urban planning literature and therefore are only outlined here. The main point of this paper is to illustrate how new interactive tools can be used to help cities address the huge challenges they are facing.

3. Cities in the Social Era

Nilofer Merchant says we are living in the "social era". (4) She has identified a series of business practices based on social that are helping a growing number of businesses thrive. Importantly, she uses the word social to mean much more than simply social media or networking (i.e. marketing and communications-related work) but rather a full integration of social-based activities into all aspects of the business.

According to Merchant, traditional businesses were successful because they could leverage economies of scale and information. In other words they had special knowledge or information and the ability to build a factory large enough to make products using that information. Today information and communications technologies

have drastically increased our ability to share knowledge, which means that companies no longer have a monopoly on information. When combined with distributed manufacturing and logistics networks, social means that anyone can make products that once could only be made by large companies.

Like businesses, cities use information to help produce services for their residents. Democratically governed cities already use a social-based process to help make decisions (elected representatives, public hearings, public involvement programs, etc.); the question is can cities expand their use of social-based techniques to increase the economic, social and physical wellbeing of residents?

The goal of this paper is to illustrate how this might be possible by proposing a structure to help identify new opportunities for embracing new interactive tools in the planning and operations of cities. This structure is illustrated with selected examples, mostly from the transport and city planning fields.

4. Proposed structure for interactive city tools

Structures help us better understand the relationships between different elements and often allow us to see where elements are missing or where elements could be combined to create whole new elements. It is with these goals that the proposed structure for understanding interactive city tools has been developed. The structure is a work in progress and will surely grow and change. The structure and examples are also presented in interactive format at the wiki <http://interactive-city-planning-tools.wikispaces.com/home>.

At the start of this research it was expected that identifying a structure would be easy, but this proved not to be the case. There are many ways of categorizing the interactive tools currently available (and new ways will probably result as new interactive tools are developed). Therefore, the proposed structure should not be considered final, but rather a first attempt at understanding how different interactive city tools work together to form a systematic approach for improving cities.

The proposed structure is based on five main elements: input, analysis, support, collaboration and output. Many interactive city tools encompass several of the elements. The elements are defined as follows:

- Input – tools that provide data collected by machine (e.g. sensor) or by humans (e.g. reporting applications);
- Analysis – tools that analyse data automatically, they include visualization and accounting applications;
- Support – tools that help people understand and use information;
- Collaboration – tools designed to help people work together to make a decision or do something, ultimately leading to:
- Output – information, activities, services, and physical things.

Figure 1 illustrates the proposed structure. The structure is organized around the idea that data is processed to achieve some end result (output). In the simplest case government data (input) is analysed and provided to the public as information (output). For example, public transit vehicle location data is analysed to provide real time arrival data. This example can be illustrated following a path along the top of Figure 1.

A slightly more complex example is when a resident uses a public reporting app to report a broken elevator (input). This data is analysed by the agency responsible for the elevator and used to prioritize repair of the elevator (output). Accounting apps in

the analysis process are used by the agency to monitor progress and report back to the public on status. This example can be illustrated following a path through the middle of Figure 1.

A more involved example would be the use of these interactive tools in developing a noise mitigation plan for a local airport. In this case noise data from sensors provided by a group of city residents (input) could be visualized and used as input to a collaborative planning process. Additional input in the form of discussion is provided by public input apps and the process itself is supported by educational apps (e.g., information about noise science and aircraft noise) and better meeting apps. The output could be the noise mitigation plan.

A fundamental quality of the proposed structure is level of public collaboration involved in the activity. For many city actions no public discussion is needed before acting. A good example is fixing an elevator. In this case the agency responsible for fixing the elevator simply needs to know that it's broken. This information can come from the agency itself or from the public. Similarly, once a public transport information system is in place, there should be little discussion needed about whether to provide real time vehicle arrival information.

The next sections describe the five elements of the proposed interactive city tools structure in more detail.

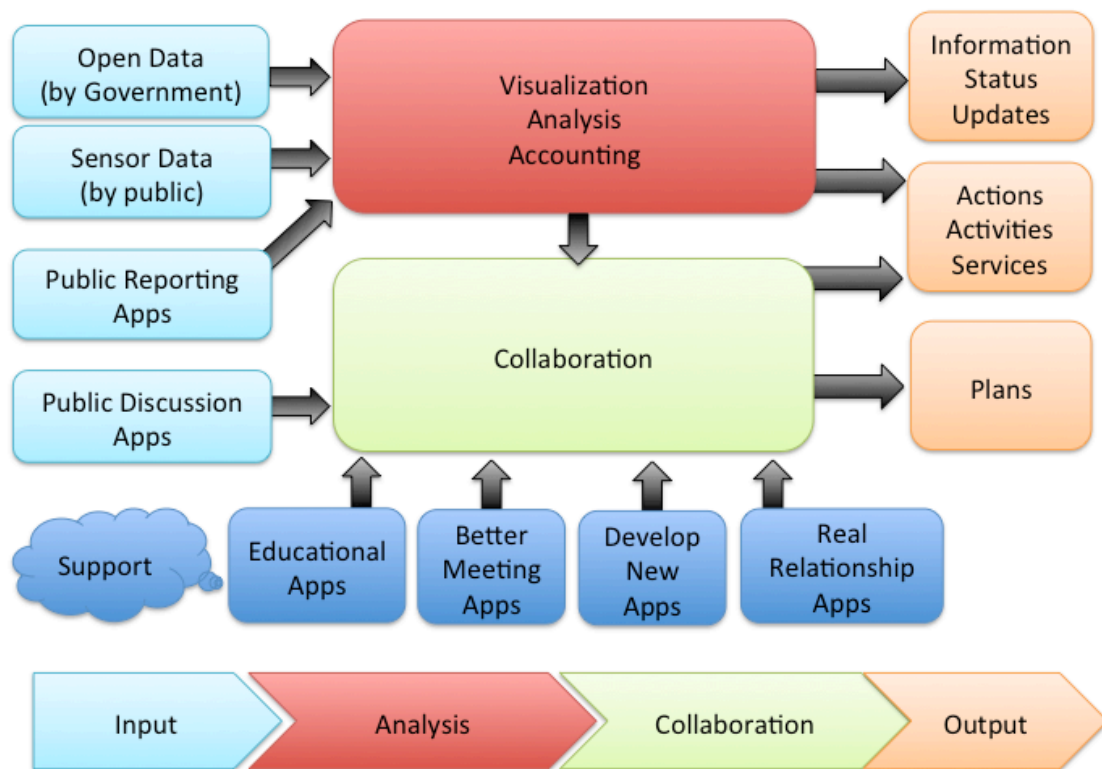


Figure 1: A proposed structure for interactive city tools

5. Input Tools

The proposed interactive city tool structure consists of four main input tools:

- Open Data – agency provided databases and real time data feeds;
- Sensor Data (by residents) – this data source has been made possible by the falling cost of sensors and the ability to easily provide data feeds on the internet;
- Public Reporting Apps – applications that allow the public to identify problems;
- Public Discussion Apps – applications that allow the public to exchange ideas and provide more detailed information for the planning and decision-making process.

The distinction between public reporting and public discussion is fine. It's clearly possible to use public reporting apps to exchange ideas and public discussion apps to report problems, but this is inefficient since many of these apps include specialized backend systems designed to efficiently process data for reports (broken elevator information goes into the elevator maintenance database) or planning processes, but not both. The following sub-sections describe all four input tools.

5.1 Open Data

Open data is when a government agency places its data online for anyone to use. (5) (6) Since there has been a great deal written about open data² only three points will be made here:

- There are very strong public policy arguments for agencies to provide open data. Many cities and agencies are already providing open data, those who do not should at least develop an open data policy and begin the process of opening their data (both because open data is often helpful and because you don't want to be put in a position of being forced to provide data as a result of a political controversy).
- Open data should be useful and be provided in a practical format. There is no point in releasing non-useful data (on the other hand sometimes it's unclear how the data could be used).
- Open data policy should focus on the value added by providing the open data. There is no point in providing open data just for the sake of being able to say your data is open. Agencies should work with members of the public in identifying data sets that could be helpful to accomplishing appropriate tasks.

5.2 Sensor Data

Today it's possible for anyone to build and operate devices (sensors) that automatically collect data previously only available using complicated and expensive equipment. Examples range from traffic counts to air quality to noise levels. This has become possible as information technology components become smaller and less expensive, and new open source control systems have been developed.

² An excellent source of information on open data policy is Andrea Di Malo who blogs often on open data (http://blogs.gartner.com/andrea_dimaiolo/tag/open-data/).

It's also possible to easily share data provided by these sensors via simple to use Internet data feeds. In short, data – which used to be difficult to collect and obtain – can now be made easily available to everyone.

As shown in Figure 1, publically collected sensor data (i.e., collected by non-government organizations or independent people) is one of the four main types of input in the proposed interactive city tool structure. Sensor-based input feeds into the analysis process where it is used to generate outputs (providing information, and helping guide actions), and/or in the collaboration process.

The most interesting aspect of publically collected sensor data is that it enables city residents to monitor conditions themselves. Community members are no longer reliant on official data. This completely upends the relationship between government and the people. (7)

A good example took place after the Fujiyama earthquake in Japan. The government said that there was no significant radiation leaking from the damaged power plants, but people with Geiger counters noticed abnormal readings. They started feeding their data into Pachube (an application that allows people to easily share data feeds) and soon a map with real time radiation readings was online. Webpages with instructions for building simple Geiger counters and connecting them to Pachube followed quickly. (8) Soon the government was forced to admit that there were radiation problems and to take action.

Table 1 presents some examples of sensors being used by the public and reference information.

Type	Name/URL	Description and References
Sensor	Trafficcom http://trafficcom.org	Traffic counting sensor and platform. (9)
	Air Quality Egg http://airqualityegg.com	Air quality monitoring sensor
	Safecast (Geiger counters) http://blog.safecast.org	Safecast is a global sensor network for collecting and sharing radiation measurements to empower people with data about their environments.
Software & Hardware	Arduino http://www.arduino.cc/	Open source electronics hardware and software for creating interactive objects or environments
	Kinect	Third party developers using Microsoft Kinect motion sensing as input to sensor devices (10)
Operating System	Cosm (formerly Pachube) https://cosm.com/	Cosm "is the platform, API and community where devices, information, developers, apps and commercial applications come together to bring connected products and ideas to life" (from website).
Example Networks	London Air Quality Network http://www.londonair.org.uk/	Mapping of air quality data from many sensors in London: Kings College London. (11)

Table 1: Public Input using Sensors

5.3 Public Reporting Applications

As a reminder, “reporting” is being used in the proposed structure to describe methods for providing relatively simple input that will be quickly analyzed and used. The public discussion application category (Section 5.5), is being used to describe applications for providing more detailed input intended to become part of a collaboration process. The distinction between these two is fine and therefore some applications could fall in either category.

The proposed interactive city tools include five types of public reporting applications:

- mainstream social networks;
- service status and reporting applications;
- GPS reporting applications;
- Survey applications; and,
- customized reporting applications.

They are outlined below.

5.3.1 Mainstream Social Media

Mainstream social media are general purpose social networks such as Twitter and Facebook. People can use these networks to report issues to cities and agencies and/or carry on conversations about services and ideas.

The distinguishing quality of mainstream social media (from the perspective of the proposed interactive city tool structure) is that they are both input and the output processes: someone posts something to the mainstream social network and it is immediately displayed as output – for example, the current status of bus service on a given line, or a general complaint about service.

The advantage of mainstream social network reporting is that networks like Twitter and Facebook are almost ubiquitous – almost everyone uses one or more of them. Several other points worth emphasizing are:

- Mainstream social media, especially Twitter, are the de facto source of real time news and information today;
- People are probably already broadcasting information and complaints about city services on mainstream social media;
- Social media can be used to develop real relationships with users.

In short, mainstream social media are an important place for cities and agencies to obtain and share information.

But, while it's very important for cities and government agencies to have a presence on mainstream social media it can be difficult since these media are very different from traditional government public relations practices. In spite of this many agencies have been successful and there are good sources of information on how government agencies can effectively use mainstream social media (e.g., <http://blog.howto.gov/category/social-media/>).

The most important question when designing or revising a mainstream social network presence is: what, exactly, will the social network be used to accomplish? The disadvantage of mainstream social networks is that, given their wide field of interests, they are quite blunt instruments for accomplishing many types of actions (i.e., in terms of the proposed structure: outputs).

This disadvantage has also been recognized in the business sector where,

"forward-thinking brands ask social media to deliver things that make business sense. Things like higher customer satisfaction, greater loyalty, reduced support costs and increased revenue. ... If you really want to engage with your customers on social channels, you need to engage on your own social hubs: customer forums, blogs and communities." (12)

In other words businesses that are successfully using social media are developing their own social media applications rather than relying on standard mainstream social media to accomplish their goals. These companies surely have a presence on mainstream social media, but use this to accomplish more general objectives.

The same approach makes sense for cities, at least from the perspective of this paper, where we are considering how cities can use interactive tools to help accomplish specific outputs (information, activities and/or plans). It's important for cities to have mainstream social media sites to share information and refer people to other applications and tools, but that's not enough, additional customized interactive tools are needed (as outlined in the following sub-sections).

One area where mainstream social media can be extremely helpful to cities and agencies is in collecting and providing real time status information. As mentioned earlier people are using these media (especially Twitter) already to broadcast status information. Cities should design their mainstream social media sites to take full advantage of information from the public.

A good example is developing a series of Twitter hashtags for services that people can use to provide and read information (e.g., Chicago Transit Agency different hash tags to help make it easier to find relevant). (13) Developing and communicating these types of organizing structure in advance is especially helpful during a crisis when many people rely on social media to obtain up-to-date information. (Cities need to have a social media plan for crisis situations.) (14) (15) (16)

Finally, mainstream social media can also provide input information that is helpful for more long term analysis and evaluation. Mainstream social media users can place comments or tweet about city services on city pages or using commonly accepted hashtags. People and groups also organize pages or Twitter accounts to share information about specific city services.

For example, in Washington DC an active community uses the hashtag #metrosucks to share complaints about the city's public transport system. These tweets can provide good information for the transit agency (WMATA) to use in improving the system. Also in Washington, @fixWMATA tweets about WMATA problems, information and solutions (and has a webpage devoted to WMATA).

Many cities and agencies are monitoring and using information from mainstream social media, but it's still unclear how to best harness the interest and information provided by these groups and activists. (17)

Several examples of mainstream social media used as are provided in Table 2 below.

Name/URL	Description
Chicago Transit Authority https://twitter.com/cta	Chicago Transit Authority Twitter feed. More information about CTA use of social media: (12)
#metrosucks Twitter hashtag	Twitter hashtag for people to broadcast problems with Washington DC public transport agency (WMATA).
Emergency 2.0 Wiki http://emergency20wiki.org/	Group formed to share information about using social media in crisis or emergency situations.

Table 2: Public Reporting via Mainstream Social Media

5.3.2 Service Status and Reporting

This category of public recording application consists of applications designed specifically to allow service users to share real time information about service quality and highlight problems without interfacing with the city or government agency. In some cases these were developed before the city or agency had their own service status information service and in some they are being developed as part of a potential business.

These applications fall in between the mainstream social media and detailed reporting applications because they are focused on a specific service (e.g., public transport) but only allow users to provide a limited amount of feedback. Table 3 provides several examples that illustrate this concept.

Name/URL	Description and References
Tiramisu Transit www.tiramisutransit.com	Crowd powered transit information system developed at Carnegie Mellon University. Users provide information e.g., vehicle location, seat availability etc.
BettaSTOP http://bettastop.net	SMS application to allow Oakland residents to give feedback on their bus ride
HopStop Live www.hopstop.com	HopStop Live! Broadcasts what other users are saying, in real-time, about the stations, trains, lines and buses you use. HopStop is a private website providing transit and travel information.

Table 3: Service Status and Reporting

While the idea behind these applications is to provide real time information to users on the quality of service, it's also important to note that cities or service providers could use this data to help develop plans for improving service. Therefore it is important to consider how these data could be saved, validated and used.

5.3.3 GPS Reporting Applications

Geographic positioning systems (GPS) are included in almost all smart devices today. This set of reporting applications provides data on the paths users follow while traveling through the city (or beyond).

The GPS-based tracking data is useful in its own right for real time status updates and to indicate the popularity of certain trips/routes/modes of travel. For example, a recent research study used GPS data to track bike riders to learn what routes they really follow. (18)

In addition to tracking, many applications also allow users to annotate their trips with additional information either in real time or when reviewing their trip later.

One key question with GPS tracking is privacy and so these applications need to carefully consider user privacy in their development. In many applications data is made anonymous. Table 4 presents examples of several GPS reporting applications.

Name/URL	Description
CycleTracks http://www.sfcta.org/modeling-and-travel-forecasting/cycletracks-iphone-and-android	Application developed by the San Francisco County Transportation Authority for monitoring cyclist paths to collect data about actual route choice, CycleTracks link includes information on other cities using the application, references and link to user group;
MeineRadspur http://cms.meineradspur.at/machmit.html	Application developed in Vienna uses GPS to record bike trips, users can ID hazards and ideas (German);
moovit www.moovitapp.com	Smart phone application uses GPS to track public transport users to obtain real time information on vehicle position, users can also provide information on conditions. (19)
StreetBump http://www.cityofboston.gov/DoIT/apps/streetbump.asp	Application using smartphone sensor and GPS to automatically send information about potholes to the city (Boston)

Table 4: GPS Reporting Applications

5.3.4 Survey Applications

Survey applications are internet-based questionnaire websites. One of the most well known survey application is survey monkey (<http://www.surveymonkey.com/>). These applications allow anyone to create surveys and collect data. Most of the applications are free for certain sized surveys and also offer more options for a certain fee (i.e. following the freemium business model).

Most survey applications are internet-based although a relatively new application called textizen has been designed for use by any type of mobile phone (in other words users can send SMS messages to complete the survey, they do not need to have an internet connection). (textizen also has a good introduction page with information on creating good surveys: <http://www.textizen.com/getstarted>.)

Surveys are extremely useful for all organizations including governments but traditional surveys are often expensive and time-consuming to design, make and analyse. The new internet-based survey applications can significantly reduce the cost and time required to complete a survey. However, a good survey still needs to be well designed. The ease of completing an online survey has led to a proliferation of badly designed surveys with questionable data.

An especially important survey design issue for government is sample representativeness. Everyone must have access to the survey (this is an important benefit of SMS-based surveys) and everyone must know about the survey. Furthermore actions must be taken to ensure that the survey is not gamed in some way (e.g., one person voting hundreds of times). It's not enough to simply place a survey on a website and assume that the responses will be representative of public opinion.

In summary, survey applications are a very good way of obtaining public input, but they must be carefully designed and administered.

5.3.5 Customized Reporting Applications

Customized reporting applications make it simpler and more efficient for cities to identify problems and monitor activities done to solve the problems. For example they allow users to indicate on a map precisely where the problem is located and allow users to provide information to the city without talking to someone. A very popular example is the website www.seeclickfix.com.

It's possible to think of these applications as on-line suggestion boxes. The idea is to give city residents a place to hand-in suggestions and provide non-emergency information to the city.

Many customized public reporting applications extend the concept of one-stop city information telephone numbers (311 in the United States) to the on-line world and, in fact, are actually connected to the 311 backend processes (i.e., the city's performance, maintenance, repair and monitoring information systems).

There are countless customized reporting applications currently in use. While it's possible for cities to develop their own applications, in most cases a city or agency will customize a generic reporting application for its particular circumstances (e.g., add branding information, include local-specific detail fields, integrate the reporting system into existing management systems, etc.).

When considering the use of customized reporting applications it's important to note that, just like mainstream social networks, many generic reporting applications already allow anyone to report problems anywhere in the world. Therefore if people decide to use an application, your city's problems will be visible even if you have not developed a customized reporting application. Again, as with mainstream social media, it's a good idea to have at least considered how your city might implement a detailed public reporting application before you absolutely need one.

It is very important to design these applications so that they are both easy for residents to enter information and easy for cities to use the information. This means good interface and back-office design. Additional features included on most of these applications include: allowing users to interact with each other, ranking mechanisms for comments/users, feedback on what happens to ideas, comments from city/agency staff, contests, etc.

Almost all these applications include features that allow users to geo-locate the reporting information they provide (i.e., the problem is here) on a map. Some applications, especially those related to crowd-sourced transportation, are essentially annotated maps.

While customized reporting applications have been used to collect relatively detailed information for planning or decision making processes in some cases (e.g., seeclickfix has been used to collect input on general plans), they are most efficiently used to report specific problems rather than to provide more general feedback. The focus is on reporting, more specifically: "Something is broken. Fix it." The focus is not on deciding what to do (that's for the public discussion apps, described in the next sub-section).

Table 5 presents examples of customized public reporting applications.

Name/URL	Description and References
SeeClickfix http://seeclickfix.org	Very popular reporting application includes mobile versions. Objective: "report neighborhood issues and get them fixed"
http://fixmystreet.com http://fixmytransport.com	Developed by UK's MySociety to identify and fix transport problems
http://verbeterdebuurt.nl	Dutch website for reporting problems to cities and agencies;
Citizens Connect http://www.cityofboston.gov/doit/apps/citizensconnect.asp	Mobile application (iOS and Android) for reporting problems. Developed by City of Boston.
Dynamic Connections	BMW Guggenheim Lab (Berlin) project for crowdsourcing bike routes. (20)
Cyclopath http://cyclopath.org	Allows users to edit a geowiki with information about biking in the Twin Cities area of Minnesota;

Table 5: Customized Reporting Applications

5.4 Public Discussion Applications

Public discussion applications are designed to allow residents to provide more detailed information to the city and to encourage discussion with other residents and city/ agency staff. As shown on Figure 1, these applications provide data directly into the collaboration process (which includes public planning and decision-making). In fact, most of these applications include both input and collaboration activities within the same application.

Like customized public reporting applications, most of these applications include features allowing users to interact with each other, ranking mechanisms for comments/users, feedback on what happens to ideas, comments from city/agency staff, contests, etc. In fact, these types of activities are a main focus of the public discussion applications.

There are two basic types of public discussion applications: those designed to be used in specific processes or for specific services (e.g., public transport), and hyper local news sources which provide general forums for discussing all types of issues related to a specific geographical area.

Table 6 presents examples of public discussion applications.

Name/URL	Description and References
Change by Us http://nyc.changeby.us	Website where people can share ideas, join or create projects, connect with other people and find resources. Created by Local Projects.
MindMixer www.mindmixer.com	Software that helps communities organize social networks for public involvement suggesting ideas etc. example for San Francisco http://www.improvesf.com/
GreenCityStreets.com www.greencitystreets.com	Uses Facebook to allow people to discuss ideas for improving public transport in their city.
Shareabouts http://shareabouts.org	Mapping tool to gather crowd sourced public input developed by OpenPlans.
OpenBlock http://openblockproject.org	Open source hyper local news and data platform supported by the Knight Foundation, OpenPlans and others.
Nextdoor http://nextdoor.com	Privately held hyper local news and data application.

Table 6: Public Discussion Applications

6. Support Applications

In the proposed interactive city tools structure support applications are defined as semi-independent applications designed to help improve the collaboration process. The semi-independent means that they can be used alone, but they are often designed as part of larger applications that encompass several elements of the proposed interactive tool structure (e.g., combined with public discussion and collaboration applications).

As shown in Figure 1, there are four types of support application: educational apps, better meeting apps, developing new apps, and building relationship apps. All four are described below. (Note: there are probably several additional types of support applications not yet included.)

6.1 Educational Applications

Educational applications are defined as tools that help users understand some specific issue or problem. They can be interactive or simply provide information.

The goal of providing educational information is to enhance the quality of public input. This is particularly important today because many urban problems are quite complex and inter-related with other issues. Thus, in many public engagement processes, the ideas suggested by the public are infeasible or unrealistic (e.g., monorail transport). The purpose of these applications is either to provide information or use processes that help educate participants in the hope of receiving better suggestions and ideas.

Examples are presented in Table 7.

Type	Name/URL	Description
Educational Games	Budgeting Games	Many organizations have created budgeting games to help residents understand financial decisions; e.g., SFCTA Budget Czar game http://www.sfbudgetczar.com/
	BusMeister http://www.greencitystreets.com/busmeister	Game designed to teach players about public transport operations (part of larger www.GreenCityStreets.com project);
Physical Visualization Applications	Participatory Chinatown http://www.participatorychinatown.org/	Interactive city planning game, avatars travel through Boston Chinatown and can view development options.
	Streetmix.net http://streetmix.net	An interactive street section builder helps people visualize how streets could look with various elements (e.g. bike lane).
	Shape Auckland Housing http://shapeauckland.co.nz/shape-auckland-housing-simulator/	Website allows users to conceptually visualize different ways of providing housing in Auckland.
wiki	GreenCityStreets.com http://improve-public-transport.wikispaces.com/	Wiki with information on improving public transport operations
Library	Next Stop Design http://www.nextstopdesign.com/welcome	Includes webpages describing important concepts related to bus stop design, to help non professionals understand design issues and encourage them to participate in bus stop design contest.

Table 7: Educational Applications

6.2 Better Meetings and Processes

These applications are designed to organize and manage public engagement processes. Table 8 presents example applications.

Name/URL	Description
City Planning in a Box http://openplans.org/2013/04/plan-in-a-box/	OpenPlans project: Plan In A Box provides a one-click toolbox for city staff to promote projects and gather input with effective websites.
Public Innovation, Sacramento, California http://publicinnovation.org/	"co-creating a new culture in government" - is building a civic innovation and social entrepreneurship ecosystem in the Sacramento region designed to help create a new culture of creative problem solving in the public sector using a series of real and on-line meetings and activities.
Participatory Chinatown http://www.participatorychinatown.org/ Community PlanIT https://communityplanit.org/	Applications designed to be 'played' in public meetings to help improve the planning process with visualization, etc.

Table 8: Applications for Better Meetings and Processes

6.3 Develop New Applications

These support tools are designed to help people, organizations and government agencies design their own customized applications.

As Section 5 illustrates, a huge amount of data is becoming available for helping manage and improve cities. However data is not useful unless it can be analysed and understood. Many people and organizations have developed applications to analyse and use the data, but most people do not have the skills needed to program or create their own data analysis applications.

Two main types of tools have been developed to help non-specialists develop applications: process-oriented tools that help people work together with application developers to create applications designed to solve problems identified by the community, and technical assistance organizations.

The process-oriented tools almost always include public meetings. CityCamp Brighton describes the process as: CityCamp Brighton brings together local government, businesses, community organisations and academia to reimagine the ways in which collaboration and web technologies will shape the future of our city. (21)

The technical assistance organizations have grown up as more and more government agencies and departments have recognized the benefits of using new technologies and data to improve services. One of the most famous examples is Code for America which assists agencies in developing applications and improved technologies.

Table 9 presents example applications.

Type	Name/URL	Description
Process	DesigningChicago http://designingchicago.com/	Designing Chicago has organized a process for crowd sourcing ideas for improving public transport information in Chicago.
	CityCamp http://citycamp.govfresh.com/about/	Unconference on innovation for municipal governments and community organizations, first held in Chicago (2010). Example, CityCamp Brighton UK http://cbbtn.demsoc.org/about/
	Simpl Challenge http://www.simpl.co/howitworks	Developed by FutureGov UK, Simpl Challenge allows people to submit ideas and organize challenges where people can work on developing solutions for social and other city issues.
Technology Assistance	CodeforAmerica (CfA) http://codeforamerica.org/	CfA helps governments become more connected, lean, and participatory by helping develop web based tools and systems.
	OpenTransportation Technology http://area51.stackexchange.com/proposals/49339	Proposed Q&A site for software developers, IT professionals, planners, transportation system managers, and anyone else interested in open transportation technology.

Table 9: Support Tools for Developing New Applications

6.4 Building Real Relationships

An important objective for commercial companies is to create relationships with their customers. The idea is that people who have a (good) relationship with a company will buy more of their products. They will feel like part of the team and be willing to pay more for their company's products.

The analogy for cities or government agencies is not so clear since in most cases residents do not have a choice in who supplies them with services (unless they move). On the other hand it's very good for a city or agency to have happy residents and if building a relationship with residents helps make them happier, then it's beneficial.

Why might such relationships be interesting? Because committed residents could help cities and agencies in numerous ways. It's possible to imagine these people participating in clean-up days or volunteering to provide service information at stations, or simply removing newspapers left by other people when they leave the bus. At any rate, this seems like an unexplored idea for public agencies.

One of the main objectives of social media is to create and maintain relationships. This is true for person to person relationships and organization to people relationships on mainstream social networks, and, as outlined earlier in customized social applications being developed by innovative companies. The question is how can cities or government agencies develop these kinds of relationships?

There are several ways interactive social tools could be used to help build relationships with residents including:

- **Understanding** – often residents might not understand why a city needs to do something in a certain way. Explaining these processes could help residents feel more connected with their city (this could be done using educational applications described above).
- **Taking comments seriously** – cities can strengthen relationships by taking comments and ideas submitted by the public seriously. This means responding thoughtfully, giving credit to good ideas and being open to criticism. These are not easy for government culturally and administratively, but new interactive tools can be used to help make the process work better.
- **Contests and activities** – cities can use social media to organize contests and activities that help build a relationship with residents.
- **Asking for help** – sometimes asking for help (or providing a list of volunteer opportunities) is enough to begin relationship building.

There do not seem to be any specific support tools designed to help cities create relationships with their residents nor are there assessments of the benefits. The idea for including it in the support tools category of the interactive city tools structure comes from the commercial sector where the idea of using social media to build relationships seems to be growing. This is an example of where the proposed structure may help highlight a new business idea.

7. Analysis: Visualization, Analysis and Accounting

In the proposed interactive city tools model, public input is used to provide information to the analysis and collaboration processes.

The key distinguishing characteristic for the analysis process is that no real decision-making is necessary before taking action (actions are called outputs in the proposed model). An elevator is reported broken and needs to be repaired. A bus is late and passengers need to be informed. In contrast, the collaboration process involves public decision-making.

In the analysis process algorithms and rules are used to process and display the input data. Analysis results are then used to guide or provide outputs and/or to provide processed information to the collaboration process.

Often the process algorithms and rules are integrated into the same applications used by the public to submit input data (i.e., the input process applications).

For example traffic counts collected by a sensor are analysed by software included with the counter and users are provided with a large number of visualization possibilities. This data can then be shared on individual websites or via sensor network data feeds (output).

Similarly, when someone uses an application like seeclickfix to report a problem the application analyses the information and provides a visualization (e.g., maps the problem). Cities or agencies have access to sophisticated back-end systems to help them track problems and solutions. In fact, the business model for most of these applications is to sell the analysis processing software (e.g., tracking systems) to public agencies.

In contrast to these community-based input applications, the open data released by public agencies is often raw data that needs to be analysed and visualized to be useful. Anyone can develop applications using this data. The processes and programs outlined in Section 6.3 above are often used to develop applications using open source data.

Application development contests are a very common technique used to develop open data applications. An interesting aspect of these contests is that community-based app developers often combine data sets in ways that bring an entirely new perspective into view. A good example from an early contest was the Washington DC application called “stumble safely” which combined geo-coded data for bar locations with police and transport information to help users find the safest places to go out drinking. The app may not be extremely serious, but it would likely never be developed by a government agency.

A major problem with the app development contest approach is app maintenance. In fact, many contests seem to have the main purpose of supporting the local application development community by providing publicity and experience to creative designers. Of course the lack of a viable business model is also true for many privately developed applications.

A recent contest to develop visualizations from public transport data in three cities (Zurich, Geneva and San Francisco) developed several interesting applications including an app that compared transit access with income levels (to measure equity) and an app that displayed a frustration index. (22)

Finally, as shown in Figure 1, taking immediate action based on the input data is not the end of the story. As described in the following section, the analysed input information is also provided as input into the collaborative process where people

consider the data and develop ideas or plans for actions and activities to be implemented in the future.

8. Collaboration and Decision Making

The collaboration process is the most exciting aspect of interactive city tools. Just as social tools have allowed customers to become more involved (i.e., collaborate) in the activities of business (e.g., helping design products, identify strategies, provide peer-to-peer support, etc.), they can also be used to allow city residents to become more involved in making their cities work.

In fact, an emerging school of thought believes that this type of empowering residents represents the real “smart city” as opposed to a more popular definition that focuses on the use of sensors and centralized planning. (23) This means cities need to create “smart citizens” rather than relying on technological solutions implemented with centralized planning. The approach is supported by the need to create places that make people happy and productive. While there is clearly the need for both centralized planning and citizen-based planning, the interactive city tools described in this paper fall mostly on the citizen-based planning side.

Since a fundamental part of the collaboration process is providing input most of the collaboration applications identified in this research were described under public discussion applications in Section 5.4. An additional type of collaboration application is the category of crowd-sourced funding (e.g. Kickstarter).

Most collaboration applications loosely follow the standard planning process: identify problems, develop solutions, evaluate solutions, select best solution, implement solution and monitor results. The applications begin by collecting public input and then provide tools for users to discuss, add to, support, or modify the ideas generated from the community.

Many collaboration applications also provide resources such as visualization tools, educational games and/or analysis data to better understand complex urban processes. These resources were outlined in Section 6.

Table 10 lists the tools provided by several applications. It is modelled after the standard planning process. The table provides an interesting snapshot of what apps are being used for today and where they might be further developed.

Application	Input	Education	Visualization	Discussion	Decision-making	Take Action	Monitor
Community PlanIT	X						
Participatory Chinatown			X				
GreenCityStreets.com	X	X		X			
Next Stop Design	X	X	X	X			
Change by Us	X						
Mind Mixer	X						
Shareabouts	X			X			
Kickstarter (crowd funding)					+/-	X	X

Table 10: Functions Provided by Collaboration Applications

None of the applications shown in Table 10 are listed as fully including the decision-making function. This is because we are using a very strict definition: the decision must be made within the interactive application. Most of the input-based applications are currently used to inform separate public decision-making processes, replacing and/or enhancing a paper-based public input process. On the other hand, as outlined below, crowd-funding applications generally don't allow real input.

Decision-making is a complex question in the real and virtual worlds. The key question is: Who decides? Some particular problems involved with on-line decision-making include the digital divide and technologies that can be used to interfere with voting systems. There is also the question of whether voting is the right approach to use for decision-making in the first place. Developing fair and equitable interactive decision-making tools is very important future research question.

Kickstarter and other crowd-funding applications provide an excellent illustration of this question. A limited community of people get to decide whether something is done. Another problem with crowd-funding (in the context of using collaborative tools to generate community solutions) is that there is generally no opportunity for public input, education and discussion. Projects are presented to the community and the community gets to decide whether they are done or not.

The monitoring function is quite straightforward and could be added to most applications quite easily if it's not already included.

The interesting aspect of Table 10 is considering how a collaborative application could be built to incorporate more of the functions.

For example, how might mind mixer be combined with Kickstarter to produce real things that the community wants?

9. Outputs

Cities and public agencies provide three main types of output: information, actions and plans. Interactive tools can be used to support all three of these outputs.

9.1 Information

Information is the most basic type of output cities and agencies provide to the public. It describes the: who, what, where, how and why of services and activities provided by the agency.

Today, agency websites are the public's first source of information for almost all government services. While cities and agencies have made significant progress in terms of providing information on line, they often fail to take full advantage of (1) the ability for new media to present information differently (in other words, they just make paper based information available online), and, (2) the ability for interactive tools to allow outside users to help provide the information. This paper focuses on the second point.

Table 11 summarizes several examples of how interactive tools are used to provide city or agency information.

Example Information Outputs	Description
Mainstream social network – by agency	Agency uses a mainstream social network to broadcast information about services and update status information (e.g., Twitter feed of public transport delays).
Mainstream social network – by residents	Community uses mainstream social network to broadcast information about city/agency services.
Agency website	Interactive tool information: e.g., appropriate twitter feeds, sensor data (real time air quality) provided on official city/agency website.
Real Time Status Applications	Community developed applications that use open data feeds to provide real time data on city/agency services.
Community websites	Community developed websites that provide community-generated and analyzed information on city/agency services, e.g. cyclopath

Table 11: Information Outputs from Interactive Tools

9.2 Actions

Actions are the real things that cities and government agencies do or support. This includes building streets, maintaining parks, education, providing public transport, providing health care, etc.

Using interactive tools to accomplish real things is at an early stage of development and is even less familiar for things normally provided by cities or government agencies. These applications help urban residents go beyond providing input to actually providing services traditionally provided by cities or agencies.

Several examples of real actions being supported by interactive tools are presented in Table 12.

Example Action Outputs	Description
Clean-up day organized via public reporting website	Community volunteers use public reporting or local information website to organize a clean-up day or other day focused on doing something for the community (e.g., seeclickfix).
Casserole http://wearethefuturegov.com/casse-study/casserole/	Program for linking neighbors who want to cook with others who need help (elderly) with a focus is on making social connections. From UK FutureGov.
P2P ridesharing	Peer-to-peer ridesharing applications provide transport for particular markets (e.g., uber).
Crowd funding (e.g., Kickstarter)	Funding for projects raised by contributions from participants

Table 12: Action Outputs from Interactive Tools

The examples in Table 12 help illustrate two important questions related to the use of interactive tools to help improve cities by taking actions, namely:

- Should interactive city applications be used to allow the community to provide services traditionally provided by government (e.g., equity concerns)?
- How could interactive city applications ever provide the more complex and/or expensive city services (e.g. crowd funding a light rail line)?

These questions are now being discussed as applications and new uses for crowd funding are entering the market. (23) (24)

9.3 Plans

A plan is a detailed proposal for doing or achieving something. In the context of cities or government agencies they are often descriptions of a physical environment or a way of providing some type of public service.

Almost all city or government agency planning processes now use interactive tools to a certain extent. The most common use is to inform the community about the planning process and to encourage them to participate (e.g., mainstream social media announcements). Many also use interactive tools to collect input and a growing number of cities are using interactive tools to support more robust discussion processes (i.e., the collaboration applications described in Section 8).

It is relatively easy to integrate interactive tools in the planning process because active community involvement programs have been used for many years to develop city and agency plans. This means there is a history and acceptance of public involvement in planning. This is in contrast with an activity like having users tweet real time public transport status – an activity that does not have an analogous non-information technology model.

Plans are also an excellent example of the point made in Section 8 that interactive city tools are not used to actually make decisions (in this case create plans), but rather to provide information to the planning process. The plans themselves are normally developed in an open public process.

10. Conclusions and Recommendations

Cities and metropolitan regions have become the most important focal points in today's highly globalized world. At the same time they are facing unprecedented environmental, social and economic challenges. Information will be the key to solving these challenges and the most successful cities will be those that best understand how to use interactive tools to collect and use information from their residents.

Why? Because information allows cities to make the most efficient use of resources and to help bring out the best from its residents.

This paper proposes a structure for helping to understand interactive tools for improving cities. The structure is useful for understanding how the tools fit together and, more importantly, for identifying opportunities for new tools or connections between tools.

The proposed structure is based on four main processes: collecting input, information analysis, collaboration, and producing output. A series of support tools help improve the quality and efficiency of the four processes. The paper defines each of the processes and support tools, and then provides examples of each type.

Given the rapid development of interactive city tools, the paper is a work in progress. However, several conclusions can be drawn.

First, the idea of developing a structure, while conceptually easy, turned out to be extremely difficult in practice. There are many different approaches for organizing interactive tools in addition to the input, analysis, collaboration and output model adopted here.

Closely related to this point is the fact that almost no interactive tools fit perfectly into one of the processes. Almost all the tools span several of the process categories. Furthermore, it's often possible to use a tool designed for one of the process categories in other categories (e.g., seeclickfix as a collaboration tool).

Almost all the interactive tools identified in this research have been developed by non-government organizations (private sector, non profits, individuals, etc.). There seem to be four basic business models:

- Sell application to a government agency;
- Sell support tools to a government agency, offer application to the public for free (e.g., seeclickfix);
- Make money from people using application (sell advertising, provide as enticement for another product, sell app itself or premium versions, etc.);
- Support application with donations (e.g., non profit).

Thinking about business models raises important questions such as: could government save money by developing the applications themselves? How can government agencies prevent being locked into particular software? These are not new questions for information technology applications, but the growing importance of these interactive tools means that they need to be considered seriously.

The design, maintenance and use of interactive tools are complex. Many government agencies may not have sufficient technical support to develop and use these tools effectively.

Cities and government agencies are traditionally conservative. For example, some agencies try to keep as low a public profile as possible and consider any input as a complaint. It is hard to integrate new interactive tools into these types of organizations. On the other hand interactive tools can help government re-think (and

improve) its internal processes, to say nothing of actually improving the services they provide.

A central part of interactive tools is social media. Social media is very difficult for government agencies because of strict reporting hierarchies and legal requirements. Furthermore, a strong commitment of resources is needed for an agency to effectively use social media. Finally, good communications skills are needed. In many ways people with the best social media skills are directly opposite skilled government agency staff members.

The digital divide is real and must be explicitly addressed when governments consider the use of interactive tools (e.g., decisions must be made in public and everyone must have an opportunity to participate, which means that, at least for the foreseeable future, interactive tools cannot be the sole means of making a decision). In other words, in spite of their importance, interactive tools are only one way of working with the public. On the other hand, it's also clear that interactive tools help increase participation by allowing those who cannot attend meetings in person to provide input.

In summary, interactive applications are a very important new tool for cities and government agencies to use in providing better information and services to their residents, and in developing better plans. New interactive applications are rapidly entering the market, providing new functionality and increasing the potential for residents to actively participate in improving their city. However, there remain many important technical and policy questions that need to be addressed as innovative cities experiment with these new interactive tools.

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