WEB 2.0 IN TRANSPORTATION:
PRACTICES, UTILIZATION, AND POTENTIAL

by

Abdulkadir Ozden

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Civil Engineering

Summer 2010

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Abdulkadir Ozden

Approved:

Ardeshir Faghri, Ph.D.
Professor in charge of thesis on behalf of the Advisory Committee

Approved:

Harry W. Shenton III, Ph.D.
Chair of the Department of Civil and Environmental Engineering

Approved:

Michael J. Chajes, Ph.D.
Dean of the College of Engineering

Approved:

Debra Hess Norris, M.S.
Vice Provost for Graduate and Professional Education
ACKNOWLEDGMENTS

I am heartily thankful to my advisor, Dr. Ardeshir Faghri, who has supported me throughout my study. Without his guidance, this thesis would never have been possible. His continued guidance has enabled me to step beyond my boundaries.

I also owe my loving thanks to my wife. She supported me in all respect during the completion of the thesis. Without her encouragement and support it would have been hard for me to complete this study.
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ABSTRACT

Advances in information and communication technology have changed many aspects of our life. Since the invention of the World Wide Web, thousands of miles became seconds in terms of reaching and using information and communicating with people. However, there were still gaps for creating an interactive communication and collaboration environment. In 2004, Web 2.0 was introduced as a new version of the World Wide Web (WWW), not in terms of technical specifications but in the ways of communication and usage. With the Web 2.0 technologies such as web-based applications, social-networking platforms, photo/video sharing, wikis, blogs, content syndication applications, mashups, and synchronous conferencing applications, web sites turn into interactive and dynamic platforms from static information providers.

Recent applications show that transportation industry has been adapting to the evolution of web technologies. In this study, Web 2.0 technologies and tools are explained in detail with the popular examples within and without the transportation field to emphasize the effectiveness and capabilities of the new version of the World Wide Web. Usage of Web 2.0 in different transportation areas such as transportation planning, public transit and public relations are presented with successfully implemented applications.

Additionally, utilization of Web 2.0 tools and applications by transportation professionals are examined with a national level survey. The survey is designed to gather information from transportation professionals about their familiarity with Web 2.0, the ways Web 2.0 is used in transportation, the most used Web 2.0 technologies and tools in different transportation study areas, and the utilization of Web 2.0 technologies at the institution/agency/organization levels. 1080 transportation professional were contacted from across the U.S. and 137 of them
participated in the survey. Survey results demonstrate that 71% of transportation professionals are aware of Web 2.0 technologies. However, only 24% of respondents utilize Web 2.0 for professional purposes and 28% of them for personal reasons. Also, participants’ responses indicate that Web 2.0 technologies are highly effective in transportation planning, transportation education and public relations areas.

After introducing Web 2.0 and presenting practices in transportation area, a Commuter Information System (CIS) is proposed to improve the congestion management by utilizing Web 2.0. CIS, which will provide real-time information to daily commuters, is aiming at relieving the effects of the congestion by informing drivers before and during their trips. CIS utilizes Web 2.0 to facilitate commuter data entry and information dissemination, and provides communication and collaboration environment for the public.

Finally, future potential of Web 2.0 and the next step, Web Squared, are discussed. Because web technologies are changing rapidly, 3-5 years predictions are presented. In this perspective, smart computers and devices are expected to be the most significant change in near future.
Chapter 1
INTRODUCTION

Due to the advances in technology, usage of web applications in transportation has been increasing. Information and communication technologies have changed from one-way data and information stream to two-way data and information sharing beginning from the 2000s with the emergence of Web 2.0 technologies. Transportation planning, operations, public relations and information dissemination have become easier, faster, and more affordable with this new way of communication by increasing the collaboration between professionals and non-professionals, providing intra and cross-agency collaboration, reducing planning time and cost, and encouraging public involvement.

The web is an opportunity for transportation agencies to provide results of the transportation studies to the public [1]. The 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) mandates that metropolitan planning organizations (MPO) should disseminate information and data via Internet by using visualization techniques in terms of public involvement which is an essential element of the transportation planning process [2].

Since the invention of the internet, web developers have been in a competition of creating more useful and usable applications. The new version of the WWW, Web 2.0, has increased the amount of information available and has enabled active web users to create, change and share custom-made web content [3]. User friendly, accessible and mostly free applications are preferred by users to contribute to
the creation of the new data age. Therefore, success of the applications comes with the “operating by new rules”. According to Jarvis [4], new rules of the new age for adapting to the social media are:

- Customers are now in charge. They can be heard around the globe and have an impact on huge institutions in an instant.
- People can find each other anywhere and coalesce around you—or against you.
- The mass market is dead, replaced by the mass of niches.
- “Markets are conversations,” decreed The Cluetrain Manifesto, the seminal work of the internet age, in 2000. That means the key skill in any organization today is no longer marketing but conversing.
- We have shifted from an economy based on scarcity to one based on abundance. The control of products or distribution will no longer guarantee a premium and a profit.
- Enabling customers to collaborate with you—in creating, distributing, marketing, and supporting products—is what creates a premium in today’s market.
- The most successful enterprises today are networks—which extract as little value as possible so they can grow as big as possible—and the platforms on which those networks are built.
- Owning pipelines, people, products, or even intellectual property is no longer the key to success. Openness is.
1.1. Problem Statement

Until the advent of the Internet, the most appropriate ways of information dissemination were printed materials such as books, reports and articles, paper maps, and media tools such as TV, radio, and newspaper. As a milestone in communication technology, the Internet has facilitated communication, collaboration and information dissemination in all parts of our life. After a decade, an updated version of the WWW, Web 2.0, came to the stage to increase the effectiveness of the Internet.

However, transportation industry has not adapted to the web developments as much and as fast as education and marketing industry. For this reason, Web 2.0 technologies and tools need to be explored for use in transportation. This study is aimed at providing a source of information regarding the effect of Web 2.0 to transportation.

1.2. Purpose and Objectives of the Study

The purpose of the study is to present the Web 2.0 technologies and tools, providing applications in transportation areas, presenting the current web technology familiarity of the transportation professionals by conducting a national level survey, and developing a theoretical framework for daily commuters. The study explores the potential of the current and future’s web technologies, Social Media and Web Squared.

The following questions constitute the objectives of the study:

- What effect do the Web 2.0 technologies have on the transportation?
- What Web 2.0 technologies and tools are being used in transportation areas? Are they effective? What is the future potential of Web 2.0?
• How much do transportation professionals and transportation agencies currently utilize Web 2.0 technologies? Are they aware of Web 2.0 and the potential of it?
• How can we utilize Web 2.0 in congestion management?
• What does the future hold for applying Web 2.0 or Web Squared in different transportation problems?

1.3. Thesis Organization

The thesis is organized into 7 chapters.

In Chapter 2, Web 2.0 technologies and tools are described in detail for providing background information. The chapter is introduced by definition and history of Web 2.0. Then, Web 2.0 technologies and tools are explained with the most popular and successfully implemented examples.

In Chapter 3, existing Web 2.0 applications in transportation area are presented in 4 categories: information dissemination, transportation planning, public collaboration and social networking applications.

In Chapter 4, results of a survey, which is conducted to better understand the utilization of Web 2.0 technologies and tools by transportation professionals and agencies, are analyzed.

In Chapter 5, the Commuter Information System (CIS), which is aimed at improving congestion management by utilizing Web 2.0 tools and applications, is presented.

In Chapter 6, the potential of Web 2.0 for transportation is discussed. Possible developments and utilization are presented.

In Chapter 7, summary of the study and recommendations are given.
Chapter 2

BACKGROUND: WHAT IS “WEB 2.0”

The innovation of the World Wide Web (WWW) by Tim Berners-Lee in 1991 was the first step of the web technology. In the beginning, only static information could be uploaded by hand to a web browser, and mostly small size of images or graphs could be used because of low-bandwidth modem connections [5]. Starting from 1996, interactive communication started to become available through Web that promoted e-commerce and instant communications. In the beginning of 2002, information sharing and exchanging with new applications (later called Web 2.0) such as Weblogs and RSS was becoming popular [6], which was the turning point for the Web.

Darcy DiNucci [7] was the first who used the term Web 2.0 in her article called “Fragmented future” in 1999. She stated that “the first glimmerings of Web 2.0 are beginning to appear, and we are just starting to see how that embryo might develop” (p.32). Later in 2003, the concept of Web 2.0 came forward for a conference by O’Reilly Media Group and its partner Media Live. They started the Web 2.0 conference to draw attention to new developments on the web and technologies. Tim O’Reilly and John Battelle defined Web 2.0 to expand the term. The most popular Web 2.0 applications are Google, Yahoo, Facebook, Wikipedia and e-commerce properties Amazon and eBay [5]. O’Reilly and Battelle stated the development of web [8]: “1990-2004 was the match being struck; 2005-2009 was the fuse; and 2010 will be the explosion”.

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Like many other areas, the transportation industry has increasingly employed Web 2.0 technologies and tools. Although Web 2.0 technologies and tools are not generally being used as a single tool or application in the transportation area, many transportation studies, planning processes and projects include a combination of the multiple tools for being more effective, collaborative and creative. This chapter introduces Web 2.0 technologies and tools with successfully implemented applications. Examples in this chapter are mostly aimed at describing Web 2.0 technologies and tools and most of the examples are out of the transportation area. Applications in the transportation area are presented in Chapter 3.

2.1. **Web 2.0 Technologies and Tools**

It is hard to define what exactly Web 2.0 is because it is a “gravitational core” rather than a concept with “hard boundaries” according to O’Reilly, inventor of the term [9]. Defining the characteristics and capabilities of Web 2.0 would be better than giving a single simple definition. However, most sources use the definition in Wikipedia [10] which is “Web 2.0 is commonly associated with web applications that facilitate interactive information sharing, interoperability, user-centered design, and collaboration on the World Wide Web (WWW)”.

Web 2.0 started with a brainstorming session between O’Reilly and MediaLive International in 2004 [9], [11]. After analyzing several web-based companies which survived from 2001 crises, O’Reilly and his team realized the importance of user-generated content and sparked the new version of the World Wide Web, Web 2.0 [11]. From “user-generated” point of view, network effect is an essential element of Web 2.0. Gehl [11] explains the network effect with a simple example: If someone owns a telephone and no one else does, the ownership of the
telephone will not be practical because it is not allow the user to communicate with anyone. For this reason the common expression highlights importance of the network effect: “as more people use, more valuable it will be”. Additionally, O’Reilly and Battelle [8] emphasize the importance of users in terms of the power of the network effect: “Web 2.0 is all about harnessing the collective intelligence.”

Osimo [12] characterizes the role of the web users in four categories in Figure 2.1.

![Figure 2.1 Role of the Web Users](image)

Figure 2.1  Role of the Web Users [12]

In this figure, the smallest circle represents users who take an active role in creating, designing and providing the content. The second biggest circle represents
the web users who improve the content by providing feedback, comments and reviews, and rating the content [12]. It could be either providing a comment after shopping at Amazon or giving a feedback to Microsoft to improve the test version of the new Windows. Both contributions have an effect on improving the content. These two circles users create a network effect by actively using the web. However, the percentages of active web-users are really insignificant compare to all internet users. Osimo [12] estimates the percentage of the active web-users who generate and improve the content is about 10% in Europe according to the 2006 data, which is about 5% of European population.

The third circle represents the people who use user-generated content. Web-users who are not commenting or reviewing but only reading the comments and reviews are placed into the third circle. The biggest circle, fourth circle, covers all internet users [12]. Osimo estimates that about 40% of the Internet users fit into the third category and 100% of the Internet users into the fourth. The percentages are important for demonstrating the lack of contribution to the web. However, as mentioned earlier, web applications are growing rapidly and the percentage of web users is growing too. According to the Nielsen [13], 74.1% of the U.S. population utilizes the Internet as of August 2009 which represents the biggest circle.

According to Morris et al. [14] Web 2.0, in another name “Social Media”, is a cost-effective and powerful tool for many organizations and agencies in terms of using the participatory communities. They distinguish Web 2.0 from the older version of the web with the following statement:

“Gone are the days when audiences are passively waiting to have information and entertainment pushed at them through a screen. Now audiences are forming their own communities and their own forms of entertainment. Advertisers must seek out their target audiences if they
wish to communicate their messages. Traditional media are now being called, “Old Media.”

The following sections present the Web 2.0 applications and tools with successfully implemented examples in twelve categories.

2.1.1. Web-Based Applications

Web-based applications are eliminating the dependency on desktops by providing access to the various applications through the web. Advanced web technologies enabled people to utilize both simple and advanced applications such as Google Docs, Microsoft Office Live Workspace, Crazy Egg, Phonevite and Mint. These online web-based applications are becoming more available and more popular day by day. According to Angelo et al. [15], there are many advantages of web-based applications and a few of them are:

**Low software requirements:** Web applications use the system *Software as a Service (SaaS)* which only requires a browser. In these applications, maintenance will be managed by the application provider such as Google, Microsoft, etc. Application providers manage maintenance and guarantee the possible content changes and user faults in reasonable limits.

**Content Ubiquity:** Content only depends on accessibility of the Internet and a web browser. Meeting these two requirements provide accessibility to the data, documents and spreadsheets anytime and anywhere.

**Collaboration:** Web-based applications are also a great example of collaboration. By using the AJAX (the technical ingredient of the Web 2.0) behind the application, collaboration becomes almost real-time editing.

Document creating and sharing is a popular field for web-based application developers. Web office suites are ubiquitous and user-friendly applications
which do not require software to access the applications. There were not too many web-based applications in the transportation area due to the size and complexity of the programs which need powerful processors and computers. However, developments in technology have reduced these downsides. Office Live and Google Docs are the most popular applications of online office suites and Mint is the merged application of the Citilabs in transportation area.

Office Live Workspace (is created and powered by Microsoft) and Google Docs (is created and powered by Google) provide a web-based online environment to create, view, store and share data and documents without any software needed. Both applications require only an internet connection and a web browser to serve users. As mentioned earlier, there are many advantages of online web-based applications such as storing thousands of documents and files without any cost, accessing the data from anywhere and anytime easily, collaborating by real time editing, managing the shared documents (only viewable, or editable by other users), and having the files protected by the application provider.

Mint is one of the leading cloud-based modeling applications in the transportation industry. Provider of the web-based planning platform, Citilabs, defines the Mint with the following statement:

“Mint is a cloud-based, hosted scalable platform for transportation modeling that provides governments and consulting firms with software-as-a-service (SaaS) benefits. In other words, Mint is a “no software” solution.” [16]

Mint allows users to conduct different transportation simulation processes and share them without using any software. “No software” solution also eliminates the accessibility problem to the transportation modeling and forecasting programs by providing an online environment which is accessible from anywhere [16].
One of the leading transportation planning software providers, Citilabs, has adjusted itself to the advances in advanced web technology by Mint. This notable step also points out the upcoming trend in transportation industry in terms of software development.

2.1.2. Social Networking Technologies and Tools

Online social networking is one of the new trends in our daily life. Millions of users and billions of posts attest to the popularity of the social networking technologies. Creating profiles, posting updates, sharing photos and videos, adding notes, creating and advertising events, sending messages, commenting to other’s posts, and keeping in touch with friends are just a few features of social networking tools. Facebook, Twitter (which is also known as microblogging), MySpace, and LinkedIn are some famous social networking sites and applications.

The popularity of the online social networking offers the idea of using it professionally for communication and collaboration. One common idea is using current social networking tools and sites in more professional ways while the other idea is creating new social networking, collaboration and communication tools only for specific purposes such as research database. There are many Facebook and Twitter pages which are created and operated by transportation departments, institutions and agencies to build an online communication environment such as Texas Department of Transportation (TxDOT)’s Facebook page and Transportation Research Board (TRB)’s Twitter page. Since the 2000s, especially with Web 2.0 technologies, information dissemination and communication has gained a new dimension. The main reason for using social networking sites by transportation agencies is to reach people via the most common tools they are using.
Social networking applications are also effective tools for researchers. Even though Web 2.0 technologies and tools provide unlimited sources and options in terms of collaboration, purely social networking sites such as Facebook and Twitter and professionally-social networking sites such as LinkedIn and ResearchGate are not being used effectively by the research community [17]. However, the potentiality and popularity of online social networking forced institutions to invest in creating new applications and using current resources effectively. According to Maxmen [17], National Institutes of Health (NIH) awarded $27 Million Recovery Act (ARRA) fund for developing social networking sites for researchers. Two teams, from University of Florida and Harvard University, have been developing social networking applications only for scientists with the ARRA fund.

Popularity of the social networking applications might change place to place. For example, some social networking sites are very popular in Europe like Bebo, some in East Asia like Cyworld, some in South America and India like Orkut [3]. However, Twitter, Facebook and MySpace are the most common social networking applications throughout the world.

In terms of agencies and companies, using social networking sites is a tremendously effective way to build an environment for communication and collaboration with the public. Easy to follow, less officiality, and time and place flexibility would be the positive sides of social networking in terms of the public. However, from transportation agencies point of view, monitoring and managing a social networking application needs time and effort to make it usable and useful.
2.1.3. Collaborative Editing Technologies and Tools

Collaborative editing is one of the most important and common Web 2.0 practices. The simplest definition of collaborative editing is “editing a document simultaneously”. Purposes of collaborative editing tools are developing the content, increasing the collaboration, and augmenting an online community. Individuals from different locations, different backgrounds and different professions are able to work collaboratively to improve the quality of work [18].

As Noveck [19] explains,

“Ordinary people, regardless of institutional affiliation or professional status, possess information – serious, expert, fact-based, scientific information – to enhance decision-making, information not otherwise available to isolated bureaucrats. Partly as a result of the simple tools now available for collaboration and partly as a result of a highly mobile labor market of ‘knowledge workers,’ people are ready and willing to share that information across geographic, disciplinary and institutional boundaries”.

Some successfully implemented collaborative editing applications are presented below:

Intellipedia, a collaborative editing system used by United Stated Intelligence Community (IC), is a remarkable example of collaborative editing applications. The system enables intelligence community analysts to share information and data in three different classification levels: unclassified, secret and top-secret [20]. Intellipedia was started with an award-winning paper by Calvin Andrus, a CIA employee, in 2004 and formally introduced in April 2006. According to Vogel and Central Intelligence Agency (CIA) web page, there were 15,000 daily contributions, about 900,000 pages and 100,000 user accounts in 16 different intelligence agencies as of August 2009 [20], [21].
Intellipedia created an online environment to share information and data between the intelligence agencies’ employees without dependency on the institutions and agencies. Osimo [12] describes the Intellipedia, wiki-based information system, that users from different agencies can create group reports collaboratively. They can also express critique and dissenting opinions in the system.

**Peer to Patent**, created by New York Law School and endorsed by United States Patent and Trademark Office, is an online system that improves reviewing process of patent applications. Collaboration of participants improves the quality of projects, reduces the reviewing process time, and promotes peer to peer interaction between innovators. Osimo [12] states that Peer to Patent improves the current patent examination process which is not efficient and fast because it requires advanced knowledge and has excessive applications.

**Cyclopath** created and operated by GroupLens Research at the University of Minnesota, is a great example of public collaboration in the Minneapolis area. It is a map mashup application in which users can edit the map. Individuals can enter routes they experienced, share problems they faced on the roads, rate trails and roads and inform other people by using the web site. The purpose of the application is to create a community for bikers to share cycling knowledge, route information and personal bikeability ratings for the Minneapolis area [22]. Rating the content, one of the popular and effective features of Web 2.0 technologies, helps bikers to find the best route or trail in the area.

**2.1.4. Blogs**

Definition of the blog (weblog) is “a personal web site that provides updated headlines and news articles of other sites that are interest to the users also
may include journal entries, commentaries and recommendations compiled by the user.” However, in addition to the personal usage, last applications and practices show that blogs can be used by governmental institutions, agencies and organizations to facilitate communication and information dissemination. The official blog of the U.S. Secretary of Transportation, Fastlane; Transportation Security Administration’s blog, The TSA Blog; and the blogs created by groups of peoples in order to establish a community to discuss transportation related issues, Greater Greater Washington, StreetBlog, and many others prove the increased usage of blogs in transportation area, even by institutions. Regarding the target audience and content provider, blogs can be named as personal blogs, expert blogs (managed by a group of people), local blogs, local advocacy blogs and national blogs [14].

Blogs include “timestamped information in reverse chronological order”, the content of which could be cited, paraphrased or linked from outside sources [23]. The following prominent examples describe objectives of some blogs briefly:

Greater Greater Washington is a blog of residents of the Greater Washington Area. The goal of the blog is to create a community including professionals, experts and general public for providing information and ideas to the officials to improve the livability of the area [24].

LivableStreets is “an online community for people working to create sustainable cities through sensible urban planning, design, and transportation policy”. The web-based system which includes sub-pages for blogging, video sharing and education, is an open source application about different planning, design and transportation issues such as: transportation and urban planning policies, innovations, climate change, sustainability and congestion [25].
Fastlane, the official blog of the U.S. Secretary of Transportation, is an online environment that provides transportation news from the first hand. In addition to information dissemination, visitors can make comments, and rate and share the content with others which are the advantages of Web 2.0 [26].

MyBikeLane is another example of blogs created by a citizen who feels responsible himself for illegal parking on bike lanes. In the web site, cyclists post photos of cars which are inappropriately parked on a bike lane and thereby publishing plate numbers of the cars. Information about the photos (where and when taken) and cars (pictures and plate number) are pointed on a map by using Google Maps powered application [12], [27].

Blogs are one of the most used and adopted Web 2.0 applications in transportation area. Currently, there are many transportation related blogs and the number of the blogs is increasing day by day.

2.1.5. Social Bookmarking Tools

Social bookmarking is storing and managing the most used or visited web pages and sharing them with others. The old way of bookmarking was simply storing the data in a specific computer in which the data was bookmarked. With the advanced technology, people can store their bookmarks in their e-mail accounts and reach them via internet all time. However, today, not only we can store the bookmarks, but also we can tag and organize them in any way we like. We can also encourage people and increase the popularity of web sites that we bookmarked by using social bookmarking applications [5].
There are many social bookmarking applications and some of them are: Delicious, Digg, Stumbleupon, and Faves. The following social bookmarking tools are slightly different from each other. Objectives, usage and user types of some applications are described below briefly:

Delicious is one of the most popular social bookmarking applications which allows users to bookmark the web pages and tag them in any way they like. By bookmarking a web page, users can see how many people and who bookmarked the same page. Also, the system allows users to see the bookmarks of other people [28].

Digg is more of a news following and sharing application in terms of purposes. The process of bookmarking and sharing is very similar to delicious. The main idea of Digg application is to determine the value of the content by user contribution [29]. This means, the more people “dig” the page, the more popular it will be.

2.1.6. Photo/Video Sharing Technologies and Tools

Photo and video sharing applications and web sites provide opportunity to publish, store and share photos and videos by using the Internet. Moreover, applications which are compatible with cell phone operating systems facilitated the process of sharing with cell phones. There are hundreds of thousands of videos and photos that are added to cyber space via web sites every day. Youtube and Google Videos are the most popular video sharing applications while Flickr and Picasa are for photo sharing.

Although many of the photos and videos are created and published for fun or for personal reasons, there are also some professional usages of the system. For example lectures, conferences, and presentations are previously recorded and
published on the web sites. Also innovative technology simulation videos about future technologies and transportation; descriptive videos to inform people about “how to make” issues; and product advertisements, applications and application instruction videos are the other professional usage instances.

Like some other professional areas, video and photo sharing technologies are being used in transportation. Maryland State Highway Administration’s video channel provides videos about projects they conduct and informative videos about Maryland highways and issues they have faced [30]. Virginia DOT, Washington State DOT, North Carolina DOT, Nashville Area MPO and many other transportation agencies are using video channels to inform residents.

Washington State DOT uses Flickr to publish and share transportation project improvement photos, construction photos and historical transportation related photos on their Flickr site [31]. In addition to the informing the public about projects, proving the construction progress with photos increases the trustworthiness and transparency of the agency.

Photo sharing applications such as Flickr focus on uploading, organizing and sharing photos online to increase the accessibility. Using the tagging system to organize photos improves the manageability by classifying them according to the content. Tagging also increases the accessibility of the photos by others if they are open to the public [14]. By simply searching a word in Picasa or Flickr, users are able to reach all photos tagged with the search word.

2.1.7. Content Syndication Technologies and Tools

Content syndication technologies are one of the most effective ways of following the content from different websites, blogs and online newspapers without
using search engines, without entering multiple websites, and most importantly without spending extra time. Web syndication is a form of information distribution to make content of the website available for other websites. These applications convert one’s website or one’s computer to an information hub by collecting the news, articles, and updates from other websites that one subscribed to based on your interests. RSS, Google Reader, Bloglines, NewsGator, and iTunes Podcast are the most popular content syndication applications with some differences and nuances.

There are benefits of using content syndication technologies for both webmasters and web surfers. By using content syndication tools like RSS, webmasters can update the content and provide recent news and articles easily to their users. In terms of web surfers, minimizing the time to access the information, getting summarized and categorized information and locating the information easily are the benefits of using content syndication technologies [32].

Podcasting is a little different than RSS based content following applications in terms of final product. Podcast provides audio and/or video following via syndication. By simply subscribing to the web sites or audio/video providers, users can download the available latest audio and video files by using the software applications. Apple’s iTunes is the most popular example of podcasting [14].

2.1.8. Calendaring Tools

Calendars are a must-have part of most professionals’ daily life. Meetings, conferences, holidays, tax returns, insurance, and payment dates, may be forgotten in our busy lives. Since the increased usage of personal computers, people started to organize the important dates in their computers. However, accessibility to the computers and manipulating the events in the calendar without the personal computer
was the main issue in terms of effective usage. After the developments in domain services such as Google Calendar and Yahoo Calendar, calendars become more accessible via the internet.

Internet-enabled smart phones open up a new era in terms of accessibility and synchronization. Adding a new event to the calendar either using cell phones or computers and getting notification via SMS, email or phone alerts increases the effectiveness of the calendaring applications. Users may also synchronize calendars between different applications such as Google Calendar and Microsoft Outlook Calendar. There is a wide usage of calendaring tools for intra-agency collaboration in many institutions, departments, agencies, and companies.

2.1.9. Synchronous Conferencing Technologies and Tools

Working collaboratively in small task groups, which is a usual practice of professional life, is one of the effective ways of increasing the quality of the final product. Synchronous conferencing tools and applications increase the effectiveness of the participants by eliminating dependency on the location and providing an online environment for communication and collaboration [33]. Arranging a time and having a computer with an internet connection are the only requirements of organizing an online meeting or conference, even for hundreds of people. Recent synchronous web conferencing tools like Dimdim does not even require software to provide video conferencing. The only requirement is a web browser [34].

There are different applications of synchronous conferencing such as webinars, audio and video conferencing, online chat, shared whiteboard, application sharing, data conferencing, and instant messaging [33].
Skype, Google Talk, and Windows Live Messenger are the most common synchronous conferencing tools since the early 2000s. They have provided chat, instant messaging, and audio/video conferencing. Common usage purpose of these tools is providing social interaction between people. However, recent web conferencing applications bring a new dimension to synchronous collaboration. Professionally designed applications for web conferencing such as Dimdim and WebEx, provide an online environment which is almost like a classroom meeting. Meeting instantly, sharing desktop with others, using webcams and chat, recording and embedding the meeting, and mashing it up are some features of using one of the awarded web conferencing tools, Dimdim [34].

In terms of transportation, online conferencing applications such as webinars are becoming more popular to facilitate the collaboration and communication. Transportation institutions like Transportation Research Board (TRB) and Institution of Transportation Engineers (ITE), software developers such as ESRI and Citylabs are using synchronous conferencing technologies (mostly webinars) to provide meetings, lectures, and sessions to their users.

Although there are many advantages of synchronous conferencing applications to increase the communication and collaboration, there are also some downsides to the system. Possible internet connection problems and computer troubleshooting are some of the possible technical problems. Not using the body language effectively and loosing eye contact are also downsides of the synchronous conferencing applications. However, saving time and money, not travelling long distances, not encountering traffic and parking problems and location flexibility are the benefits of using synchronous conferencing applications.
2.1.10. Tag Clouds

Tag cloud is the content visualization of a web page in different types: most used word frequencies, most popular word frequencies and subcategory frequencies. Most used type of the tag clouds show the 20+ words from the content of the web site to visually present the frequencies as shown in Figure 2.2. So, the biggest size represents the most used or hit word on the website. The goal of the tag clouds is to give a big picture from the web site. Figure 2.2 provides an example of a tag cloud from ZeroStrategist.com web site [35].

![Figure 2.2 An Example of a Tag Cloud [35]](image)

Application in the following web site shows the effectiveness of a tag cloud. [http://chir.ag/projects/preztags/](http://chir.ag/projects/preztags/) A graduate student created this tag cloud application by using the speeches, official documents, declarations, and letters written by the presidents of the United States between 1776 and 2007. Most used words in the documents represent the bigger sizes. By simply moving the slider from left to right in
the web site, the dominant words give an idea of the agenda of the presidents at that time. For example, “Constitution”, “Mexico” and “war” were dominant between 1845 and 1850; “Spain” and “Cuba” between 1897 and 1900; “economy”, “Japanese” and “war” between 1945 and 1948; and “terrorist”, “weapon” and “war” since 2001 [36].

2.1.11. Virtual Games

A virtual environment is a computer-generated, three-dimensional representation of a setting which could be used for different purposes such as games, simulations and even education. Virtual worlds are the next level in social networking by using avatars. Although they are called “games” because of the computer based unreal representation, virtual worlds are beyond the game. Aldrich’s [37] statement about the virtual worlds helps us to better understand the dimension beyond the game:

“Games are fun, engaging activities usually used purely for entertainment, but they may also allow people to gain exposure to a particular set of tools, motions, or ideas. In contrast, simulations use rigorously structured scenarios carefully designed to develop specific competencies that can be directly transferred into the real world.”

Aldrich [37] likens the virtual environments to swimming pools for children in terms of learning and practicing actions before the real world. There are many virtual games designed for different fields. Some of them are: SimCity Series by Electronic Arts for urban planning and social psychology, Sid Meier’s Civilization Series by Firaxis for history and social sciences, and Zoo Tycoon by Microsoft for planning and economics.

There are many agencies, organizations and universities who are seriously taking action in virtual worlds. For example, University of Delaware has a campus in Second Life and also provides lectures, meetings, discussions, seminars, and radio
programs occasionally. Some of the events are regularly performed through the virtual worlds [38].

Another great example from transportation area is Los Angeles Metropolitan Transportation Authority in Second Life. Metro is one of the leading transportation authorities in SecondLife. It provides a transportation library, gives links to Metro maps and Trip Planner via Google Transit, presents a historical photography collection, and offers a link to contact Metro [39]. Los Angeles Metropolitan Transportation Authority [40] stated the reasons for utilizing Second Life:

“Second Life is a rapidly growing application for libraries, academia, and government entities. Participation in Second Life and our mission go hand in hand. Visual literacy is an important skill which continues to grow in the increasingly technological aspects of our daily lives. It enhances our ability to demonstrate, share, and collaborate with others who are not physically nearby.”

Virtual games and simulations have been used by U.S. military for teaching, socializing and training purposes for decades. According to the U.S. Army Simulation, Training and Instrumentation Command, Michael Macedonia [41], Department of Defense has been using games and simulations to build teams and improve skills. Macedonia emphasizes the determination of the U.S. military in terms of the importance of the simulations and games: “The United States has incorporated war gaming and simulation into the curriculum of every war college and into the operations of every commander-in-chief (CINC) headquarters”[41].

Examples and applications show the effectiveness and capabilities of the simulations and virtual games. In terms of transportation, more consideration should be given to games and virtual worlds to understand their capabilities. Comparing the
old version traffic simulations in 1990s and recent simulation techniques exposes the importance of the virtual worlds. Capabilities of current traffic simulation models such as Vissim show that the simulation industry will almost imitate real-world situations. Driver behaviors, pedestrian movements, and different transportation modes (rail, transit, etc.) are some new features of simulation models for the last couple years. These advanced simulation techniques shape the future of transportation in virtual worlds.

2.1.12. Mashups

Mashup combines multiple services and data to create a new application in terms of definition. For example, a real estate web page which uses Google Maps or Yahoo Maps to display houses on the map on its web site is a mashup. It merges the data for houses (geographic locations, pictures, prices, information, etc.) and the map which Google Maps provides. This combination is named a mashup application in web development literature.

The last decade has witnessed advanced web-based interactive mapping in terms of technical capabilities and visualization [1]. Map mashup applications are becoming an essential element of transportation studies and implementations by using the power of the map application programming interface (API) providers such as Google Maps, Yahoo Maps and Bing Maps. Ease of implementation with nearly no cost increases the usage of the applications even by non-professionals and the general public. Google Maps has been providing API since 2005 to allow users to create map mashups and present the data and information on Google Maps [42].

Batty et al. [42] highlights the importance of the map mashup applications:
“This obviously addresses the fact that it is now possible for users other than professional geographers, geographic information scientists and cartographers to create their own map content, and this has the potential to broaden the domain of interest and applications quite radically.”

Google Transit provides public transit information such as routes, stops, travel time, and schedules for planning a trip by using the public transit. Wikimapia allows users to name the places (cities, districts, schools, hospitals, shopping centers, restaurants, parks, lakes, etc.), and add photos and descriptions by utilizing the user-friendly sketch tools on map powered by Google. Gapminder uses the statistics of the countries and displays the time series of the developments of countries. WalkScore shows the walkability of a neighborhood by displaying the surrounding environment, community and transit accessibility on a map. These are just a few examples of mashup applications that combine the data from different sources to develop new applications.

In terms of transportation, there are many mashup applications which provide valuable information created by using tons of data from different sources. Displaying transportation department’s traffic cams on a map, displaying traffic information on a map, displaying work zones and closures on a map is some simple applications that we all are familiar with. As an unusual example, New Zealand’s Virtual Highway product allows people to choose routes they want to travel on a map and watch a pre-recorded version of the same route by fast forwarding [43].

As a different application than a map mashup, Gapminder provides statistical time series of the developments of countries. Gapminder defines its goal as “converting boring numbers into enjoyable, animated and interactive graphics” [44]. Tracking the developments in countries, regions, and states is easy and enjoyable with Gapminder. It uses the data provided by governments and organizations such as
European Union. Gapminder illustrates the effective visualization of the data and easy to use interface.

Figure 2.3 Registered Motor Vehicle (per person) and Road Accident Death (per 100,000) in 1995 [44]
Figure 2.4  Registered Motor Vehicle (per person) and Road Accident Death (per 100,000) in 2006 [44]

In Figure 2.3 and 2.4, registered motor vehicle and road accident death relation is illustrated for all states in the U.S. Each circle represents a state and states are categorized in terms of geographical location by different colors. By simply keeping mouse cursor on a circle shows the name and the data of the state which is represented by that circle or choosing the state from the list on the right side highlights the position and the data of the representative circle. Additionally, clicking the play button on the bottom left demonstrates the change of the data by the time. In Figure 2.5, highlighted path represents the data between 1990 and 2006 for the State of Delaware in terms of registered motor vehicles and road accident deaths.
2.2. Advantages and Disadvantages of the Web 2.0 Technologies and Tools

It is important to point out that Web 2.0 technologies are still new and need new approaches in order to use them effectively. Even though there is a huge potential of web based applications to improve the quality of personal and professional life, there is also downsides of using these applications that should be considered before adapting them.

The most attractive advantages of Web 2.0 technologies are being user friendly and mostly cost-free which also offer high level of public and professional
participation and lead up collaboration between them [12]. Another advantage of Web 2.0 is that asynchronous communication opportunities eliminate time and place restrictions. The technology has changed the profile of web and internet users from being only viewer to active participants. Individuals are able to contribute to content and decision making process. It is also important that these technological tools promoted personal learning because most information and knowledge became open sources with web applications [12], [45].

The new developed internet technologies enabled such online platforms in which people are able to access a huge amount of information from multiple sources, have opportunity to comment and edit on the information. They could also make better decisions because they have access to all different point of views instead of one. It seems that “Web 2.0 would make the Internet a true democratic system, a digital democracy” in this century [12], [45].

There are also disadvantages of Web 2.0 technologies and tools as well. These technologies increase the dependency on the Internet and computers, even mobile phones. All applications are also time consuming. Privacy and security issues are other important points especially for governmental institutions and agencies [12]. Open source applications always have a potential for hackers [45]. “Behavior of the users” is another considerable dimension of Web 2.0 applications. Destructive behavior and low quality of the contribution may affect outcomes of the application [12].

2.3. Summary of the Chapter

In Chapter 2, Web 2.0 technologies and tools are presented. History of Web, emergence of Web 2.0, differences, improvements, advantages and
disadvantages are discussed. 12 main components of Web 2.0 are described with successfully implemented applications.

Collaborative editing applications, blogs, social networking applications, synchronous conferencing technologies and mashup applications, which are the most common Web 2.0 applications in transportation area, are also explained in detail to prepare a substructure for Chapter 3.
Web 2.0 technologies are already being used in transportation not only for information dissemination and public relations, but also for fundamental operations and activities such as planning processes, decision-making processes, and intra- and cross-agency collaboration. There are many successfully implemented Web 2.0 applications in the transportation area. Wikis, collaborative editing tools, social networking applications, and map mashups are the most popular applications in the transportation area. Each one of the technologies explained in Chapter 2 could be an application by itself as given by the Intellipedia example. However, in the area of transportation, Web 2.0 tools and applications are mostly combined and utilized in a planning process or in public relations.

In this Chapter, Web 2.0 technologies and tools applied to transportation areas are analyzed in detail. There are some applications created by using mostly Web 2.0 technologies and tools such as SeeClickFix, and there are some only partially using Web 2.0 such as Build Your High Capacity System by Oregon Metro and Peer-to-plan CSS 2.0.

Web 2.0 technologies are evaluated and classified in four categories in terms of transportation: Information dissemination applications, transportation planning applications, public collaboration applications, and social networking applications. It is hard to define the boundaries of the categories because, as stated earlier, transportation applications and studies mostly use multiple Web 2.0
applications. For example, some transportation planning processes may include both social networking tools and information dissemination tools. These categories are considered as a general classification of the applications in the transportation area. It is important to note that public collaboration applications are considered as originally created and managed by the public such as in the case of SeeClickFix and ride-sharing applications.

Osimo [12] states that Web 2.0 technologies have already been used in many activity areas of government by citizens and employees, and there is a large potential for new applications. Presently, many transportation agencies and organizations are commonly using subscription services and/or Web 2.0 toolboxes on their websites, such as “Get Connected” and “Follow Us”. With these services and toolboxes, once users subscribe, they will receive information, updates, emergency situations, closures, etc. via Web 2.0 tools such as Facebook, Twitter, Flickr, RSS and many others.

3.1. Information Dissemination Applications

Web 2.0 applications are already being used for dissemination of transportation and traffic information. We have witnessed the explosion of the Web 2.0 application market with the increase in usage of the Internet and mobile phones. Internet-enabled devices such as iPhone, Blackberry, Kindles, and Ipads have an impact on dissemination of real-time information. In addition to providing easier and faster access to information, mobile phones make creating and sharing information more efficient.

Social networking applications and blogs are the most famous Web 2.0 information dissemination tools in transportation. News, updates, emergency issues,
developments, and traffic information reach people quickly and at no cost. The official blog of the U.S. Secretary of Transportation, Fastlane; the Transportation Security Administration’s blog, The TSA Blog; and the Transportation Research Board (TRB)’s Twitter page are some popular information dissemination examples of Web 2.0 in the transportation area.

Advances in web technologies have improved the web-mapping applications in the transportation area. Mapping applications, which are some of the most common visualization techniques of transportation studies, have changed dramatically after the web-based mapping services and tools. Geographic Information Systems (GIS) and web-mapping services such as Google Maps, Bing Maps and Yahoo! Maps enable people to create, store and disseminate the large quantity of data on simple, understandable and visually nice maps. Web-mapping services facilitate displaying the data on a map by providing application programming interfaces (API). Therefore, even non-expert users are able to display the data on a map by using web-mapping services because user-friendly web-based mapping applications ensure simplicity and functionality at the same time [1].

Many mapping mashup applications in the transportation area facilitate accessibility of the transportation data by converting tons of data to maps, graphs, and tables. Utilizing the GIS and web-mapping services improves the quality of the outputs of transportation studies. Flammia and Rabinowicz [1] state that users can reach the data as soon as it is available and do not need to download the data and use specific software to view it. Google Maps and Bing Maps, which are real-time traffic information practices, show the easiness of reaching real-time traffic information.
For example, in a study, Welch et al. [46] state that most transportation organizations and firms do not yet store all the data digitally, and many times accessing and using the data become an issue. As a result, they established a system to store and view the traffic count data for intersection and roadways in Google Maps. This system enables accessibility of the data by interested parties in addition to the organizing and storing of data on the web. Users can find am/pm traffic counts, counts for different time ranges (last 3 months, last year, etc.), and intersection and roadway counts [46].

Following examples demonstrate transportation data and information dissemination in different ways via Web 2.0:

**The Census Transportation Planning Package (CTPP)** provides visualization of the fundamental source of many transportation studies, home-to-work flow data, in another name origin-destination (OD) matrix. The CTPP web-based Mapping and Query System utilizes GIS and advanced web technology to make the census transportation data stack to a visually nice and easy to understand source. User-friendly interface, dynamic data services, map-aided geographic entity query, multi-dimensional data query, and map-based charting are some of the features of the web-based applications. Total workers, mean travel time and aggregate travel time are some of the results of the application in Travel Analysis Zone (TAZ) level [47]. The application is also able to provide GIS shape files for some of the results to make it compatible with GIS desktop applications.

From a Web 2.0 point of view, combining the census data and visualization of GIS is an example of properly using mashup applications. Additionally, reaching most of the census data and visually displaying it without
needing to download or use software is an example of the effective use of web-based applications.

**Google Transit** is one of the most popular examples of an information dissemination tool used in the area of transportation. Although it looks like a simple navigation application for many people, energy and effort behind the system is the sign of the collaboration. From a technical point of view, Google Maps is the underlying platform of Google Transit. However, only with the contribution of federal and local transit agencies will the application be valuable and effective for providing public transit information. As mentioned in the example in Chapter 2, having a telephone which no one has, does not provide communication between you and other people, because only you have the tool. By pooling their information resources, Google Transit and federal and local transit agencies will better their product and make it accessible to more users. Transit authorities will provide information about routes, schedules and the location of the stations to Google Transit to make the public transit information easily accessible [14]. Users are able to plan their trips by using Google Transit in a single step even with possible route options without entering different public transit websites and spending too much time.

**gCensus** is another web site which visualizes the Census 2000 data by using the Google Maps. It is created by a web-developer team to transform the Census 2000’s row data to more understandable visual tabular information that is freely and easily accessible to the public. Users are able to navigate on the map to zoom in to the level of the data they need and to expand the Census 2000 data for any given area. One of the best features of the gCensus Website is that users are able to create a link to specific data. Creating a link to specific data allows users the option to save and/or
share the link by using copy and paste features. When the link is clicked, users can see the exact detail of the data and map without navigating to it. In terms of information dissemination, displaying the Census 2000 data on a map provides information and data for the general public, third party developers and professional agencies that would be beneficial to them [48].

**MassStats** website is an excellent example of visually providing a wide variety of transportation data. The data which is collected from different sources such as the U.S. Census Bureau, Massachusetts State Police, Massachusetts Department of Public Health, and Federal Emergency Management Agency (FEMA) is categorized in different groups (Demographic, Economic, Education, Transportation, etc.) and visually presented on a map powered by the Maptitude for the State of Massachusetts. Figure 3.1 is a screenshot of the MassStats webpage, which shows the mean commute time by city/town level on the map and a table to display some quantitative information such as population, registered vehicles, commute time, commute types, vehicles per unit and average vehicle age for the Boston area [49].
Figure 3.1  Screenshot of MassStats [49]
From the point of view of Web 2.0, MassStats website provides information on a wide variety of data by combining the different sources for a new service. The power of the web-mapping applications is that they increase the effectiveness of the data by visualization. Reliability and popularity of the application depend on the availability of the data. The absence of data or dependence on a single source such as the U.S. Census Bureau will definitely adversely affect the quality of the service. Providing data might also increase the cross-agency collaboration for further studies and applications.

**FlightRadar24** is a different type of application in terms of information dissemination. The website, which was launched in Sweden in 2007, shows live airplane traffic over Europe and other continents. From a technical standpoint, ADS-B transponder-equipped aircraft signals are received by ADS-B receivers. About 60% of passenger aircrafts and some military aircrafts have the transponder, and there are about 100 receivers across Europe [50]. The position of the aircraft, their flight path, and the location of the airports are shown on the map, and flight information (aircraft model, airline, altitude, ground speed, destination, etc.), filtering tools, chat panel, and some additional features are shown on a different panel on the right side (Figure 3.2). The chat panel also provides social networking for followers. A dynamic map changes every few seconds to provide real-time information. Developers of the application also collaborate with individuals who have ADS-B receivers by sending a script to their computers to enable them to send the received flight information to the center [50]. In addition to the FlightRadar24 website, the ISTStatus application, which uses the FlightRadar24 website to provide flight information for Istanbul Ataturk Airport, enables people to listen to conversations between pilots and tower [51].
Figure 3.2  Screenshot of FlightRadar24 Web Site [50]

3.2. Transportation Planning Applications

Usage of the Web 2.0 technology in transportation planning processes is becoming more common. Many transportation agencies are using Web 2.0 technologies to expand the accessibility of projects to the public and to transportation professionals. The purpose of using the Web 2.0 technology in transportation planning processes is to increase the productivity of employees in terms of collaboration and communication and to disseminate the information in more effective ways. Although the title of the category is Transportation Planning Applications, the content of the
applications involves a wide variety of transportation services such as transportation design, maintenance, operations, and public relations. Web 2.0 tools, however, are the most utilized in transportation planning processes, especially in public relations.

Public involvement became more efficient and effective in the planning process with the aid of the Web 2.0 technology. Guidelines and regulations require public involvement for all major transportation projects, but many public involvement programs are organized to meet minimum requirements. However, some agencies have realized that the quality of public involvement affects the quality of the project. High-quality public participation might improve projects, reduce superfluous ideas, and decrease project implementation time [19].

Another contribution to the process is creating a community between professionals within and without the agency or project team to improve decision-making processes. For example, an expert can make a contribution or solve a problem from thousands of miles away without any expectation if one makes one’s projects, problems, methods and processes accessible. Naik and Nash [19] aimed at establishing a network from “self-selected and invited experts” by using Web 2.0 tools in a major transportation planning process.

The following examples illustrate Web 2.0 implementations in the transportation planning area:

**Build Your High Capacity System** is created by Metro as a part of the 30-year regional transportation plan for Oregon. Metro has been working on a long-range plan for light rail, commuter rail, bus rapid transit, and rapid streetcars in the Portland metro region since 2008 to develop a guideline for appropriate investments [52]. As part of the project, Metro has developed the Build-a-system tool to
collaborate with the public in the planning process to learn more about priorities and choices of potential users of the system.

The Build-a-system tool includes corridors and activity centers in a mapping mashup application. Transit Corridors between centers are evaluated and selected in advance by a project team and presented on the map to enable users to select preferred corridors. After the professional evaluation, corridors also include information about capital cost, operating cost, ridership, travel time, and environmental benefits. A user can choose corridors and create his/her own high-capacity transit system, depending on what is the most beneficial or appropriate for him/her. Next, the application provides the ridership, travel time, cost, and environmental benefits of the total system according to the user’s choice. Users are able to evaluate their systems, create different corridors and compare them, and submit the high capacity system they created to make it available to other users and professionals. An important point of the application is that all users have the same budget, which equals the possible investment amount for a high capacity transit system. The limited budget prevents creating imaginary and unaffordable examples [52].

Metro provided a great application to facilitate effective public involvement in the planning process of a major transportation project. In the short time between March 23rd and April 26, 2009, over 4,250 people used the Build-a-system tool, and 657 of them submitted their thoughts via corridor selection and questionnaire. By using appropriate Web 2.0 technologies such as mapping mashup applications, users were able to use and reflect their choices and priorities easily. Users evaluated their system, budget, and corridors by using the questionnaire part of
the application. For instance, two-thirds of the respondents were not satisfied with the budget, and ridership was found the most important evaluation criteria by three-fourths of the respondents. 70 percent of the respondents suggested the combination of radial and circumferential lines for the footprint of the system [52].

Figure 3.3  Screenshot of Build a System Tool [52]

In another example, the U.S. Army Engineer Research and Development Center (ERDC) has been using Google Earth to improve the visualization of decision-support system applications and to increase cross-agency communication and
collaboration. The goal of the system is to create an online environment to store and display all the necessary data and information. Authorized users from different locations and departments are able to edit and use the data collaboratively to create a system which has up-to-date information and data.

In addition to storing information and data, the aforementioned applications show the contribution of the online environments to decision-support systems designed for departments such as transportation, geospatial research, and military engineering in the U.S. Army. The Airfield Management application provides real-time information about the infrastructure, surface condition and load-bearing capacity of airfields by using Google Earth. The Transportation Information System (TIS) controls transportation activities between units in the U.S. boundaries. TIS stores all the road networks in different layers for different priorities and improves the planning and decision-support system. The Airfield Location Tool provides information about the locations of airfields and terrain near the airfields. In addition to the U.S. airfields, many other airfields that are utilized by the U.S. army mostly in Iraq and Afghanistan are covered [53].

All three applications provide all the necessary information needed for a specific purpose in an online environment by using the effective visualization techniques and mapping tools of Google Earth. Beyond the mapping applications, establishing an online environment by editing the content collaboratively is another Web 2.0 utilization point that should be considered.
**Go To 2040 Invent 2040** is a similar application with Metro’s Build Your High Capacity System in terms of providing information about the planning process of a major project and improving public involvement in the decision-making process. The Chicago Metropolitan Agency for Planning (CMAP) describes the objective of the Go to 2040 Invent 2040 as follows:

“Our future depends on transportation, housing, water, education, jobs, air quality, and many other quality-of-life issues. You can have your say to influence decisions that will shape the region for decades to come.” [54].

The process began in 2007 to develop a comprehensive regional plan for the Chicago area. The plan not only contains transportation and land use developments but also considers economic developments, environmental issues, housing, education, health care, and social services for a better prediction of the future [54].

The screenshot of the evaluation tool visually demonstrates the changes possible by manipulation of the users (Figure 3.4). The well-designed interface gives possible choices (on the left side in Figure 3.4) for 2040 in terms of development density, road network improvements, transit system, and policies. Users are able to choose possible developments and see the effect of the changes on the outcomes menu on the right side of the screen. The middle part of the screen provides visualization of the changes by time on a map or in a graph. These are just a few of the features of the web-based application. Users are able to plan different scenarios and share them with others. They are also able to compare their scenarios with some possible solutions and rate other scenarios in the web-based application.
Peer-to-plan CSS 2.0: A Web 2.0 Application to Facilitate Public Collaboration in the Project Planning and Design Process is a concept of public involvement in a major transportation planning and design project by using Web 2.0 technologies and tools for the California High Speed Rail (HSR) project. One of the most used tools for facilitating public involvement in a planning process, Context Sensitive Solutions (CSS), is also used as a part of the concept [19].

The peer-to-plan CSS 2.0 concept aims to increase the collaboration between groups (either professionals or non-professionals) to evaluate the part of the projects and environmental documents and to make comments and recommendations to the responsible departments. The concept plans to create an opportunity for
participation, to establish a network from self-selected and invited experts, to capture new ideas, to increase collaboration and communication, and to provide real-time, online public participation [19]. According to Naik and Nash, Peer-to-plan is not an additional part of the planning process, but rather another public involvement: it could be used instead of some of the common public involvement steps. Also, high-quality public involvement positively affects the success of the project by improving the design, reducing the public opposition, and reducing the cost, correspondingly. In a public involvement program, the quality of the participant groups represents the quality of the content, reports and comments.

Peer-to-plan CSS 2.0 includes 5 major parts:

A Wiki-based planning document is the place that participants can find all necessary information about the project: description of the design, explanations and definitions, diagrams, photos, simulations, etc.

A Design library provides design options to the participants. Possible solutions are explained and documented for different types of problems, such as railway crossings, geometric design elements, and bridge designs.

An Environmental impact library is a wiki-based library for environmental issues. Regulations, technical standards and evaluation techniques are presented in this platform.

A Google sketch-up design center is a place that users, either individuals or groups, can design their approaches to the Peninsula HSR project.

The Peninsula HSR social networking center facilitates the communication and collaboration between users and decision makers. Participants can
discuss ideas and make recommendations, and decision makers can also collaborate with participants and give feedback to them about their designs and applications [19].

3.3. **Public Collaboration Applications**

We have witnessed that availability and wide currency of communication and collaboration tools have dramatically increased the contributions of creativity by the public. Thousands of people are coming together in an online environment and contributing toward a common goal. One of the core elements of Web 2.0, which is user-generated content, is the main source of the public collaboration. This section explains applications which are created and managed by the public, either by professionals or non-professionals. Public involvement in a transportation planning process is explained in section 3.2. To be frank, transportation agencies are not working effectively on non-motorized transportation modes such as bicycle and pedestrian issues. For this reason, sometimes citizens establish a community to work collaboratively for a solution of a common problem.

Wikipedia and Trapster are two key examples needed to understand the power of public solidarity. Wikipedia, which was created from the collaboration and contribution of the public, is becoming one of the biggest information sources for people. Thousands of people are improving the content of its website daily.

In Trapster, 6.5 million people post the locations of traffic law enforcement tools (radars, red light cameras, police locations, etc.) to make other people aware of them. About 7,000 law enforcement locations are posted daily throughout the world, which clearly demonstrates the capabilities of public collaboration [55].
Another public collaboration area is car-sharing applications for reducing traffic, congestion and the cost of trips by eliminating the dependency on personal cars. One common way of car-sharing is carpooling or vanpooling. Generally, in metropolitan areas, many people living in the suburbs and commute long distances every day. Some carpooling/vanpooling websites such as eRideShare and CarpoolConnect, social networking groups such as Zimride, and cell phone applications such as Avego have increased the popularity of these applications. On the eRideShare website, there are 12,356 daily carpool rides, 1,906 cross-country rides, and 149 shopping, medical or airport-related rides made daily as of June 20, 2010 [56].

A second type of application for car-sharing is managed by companies like CitycarShare for the San Francisco area, iGoCarSharing for the Chicago area, and Zipcar for the entire U.S. Users can create an account on the website by providing all the information necessary to be able to use the cars and reserve them for a specific time on hourly/daily-based rates. These applications increase the number of short trips a day without requiring the daily rental of a car. Many people in metropolitan areas use car-sharing applications for shopping, airport rides and short distance trips. The many choices for car models and the availability of cars in several convenient places around the metropolitan areas increase the popularity and accessibility of this car-sharing option. Another convenience is the compatibility of cell phones with some of the applications in providing real-time information for reserving and locating the cars.

Google’s car-sharing program: There is a car-sharing program, different from other applications with which one is familiar, at Google Inc’s facilities in Mountain View, CA. The aim of the free-car sharing program is to reduce commute
traffic to and from the facilities by providing cars to employees to use during the day, if needed. Employees who come to work by public transportation, Google’s shuttle, carpooling, biking, or walking are able to use corporate cars during the day for their meetings, errand runs, etc. This program is a part of the RechargeIT project and is conducted for the purposes of analyzing greenhouse gas emission usage of the plug-in cars as well as decreasing the commute to and from the facility. The RechargeIT program provides the findings of this project, such as emission calculations, charts, and graphs to the public on their blog.

**SeeClickFix** is one of the best examples of public collaboration by using Web 2.0 and cell phone applications for problem identification. The mission of the application is explained on the website as “encouraging residents to become citizens by participating in taking care of and improving their neighborhoods” [57]. The CEO of SeeClickFix, Ben Berkowitz, said in an interview with Felicia Hunter: “There is a big difference between being a resident and being a citizen of a community, by which he meant to highlight the importance of local participation in local issues and solutions [58]. SeeClickFix is a process by which citizens report non-emergency issues to make the issues available to the public and responsible agencies. A user-friendly website and compatible cell phone applications provide the opportunity to public and agencies to report and monitor issues easily and at no cost.

Individuals, who feel responsible in their community and neighborhood, are able to report any issue affecting their neighborhood, community, or environment, such as safety issues, traffic problems, missing signs, pot holes, pedestrian issues (sidewalks, crosswalks, etc), trash problems, and graffiti. In terms of transportation, congestion problems, signalized intersection problems, safety issues (icy roads, unsafe
turning lanes, speed limit issues, etc), missing signs, and marking problems are the most commonly reported issues on the website. Users are able to contribute to the application by agreeing on others’ reports or following reported issues.

In terms of agencies or responsible departments, it is easy to monitor any area without any cost. A user-friendly mapping mashup application allows anyone who wants to monitor an area to filter the issues reported by using the input box on the left side. Also, the SeeClickFix application emails reported issues to the watcher (either an individual or an agency) as soon as they are reported. In addition to watching an area by using the SeeClickFix website, agencies can also embed the watching area map into their own websites by using the SeeClickFix widget.

The SeeClickFix is a great example of public and professional collaboration by using an online application. “Agreeing” other issues, sharing issues with others, posting issues to social networking websites, and following issues and responses are the advantages of the Web 2.0 applications, which are used in this application. The mapping mashup application gives people the ability to identify the location of the issues on the map, create a watching area, and even embed the map in their website, for example. Cell phone compatibility of the system enables users to report an issue by simply clicking a button. Citizens are also able to post photos about the problems to make it more clear and understandable.

Applications such as SeeClickFix are embraced by local transportation authorities and municipalities to improve the livability of the community. Many local agencies and municipalities, such as the City of Manor and the City of Bainbridge, are utilizing SeeClickFix to create a communication and collaboration tool with the community and to be able to serve their residents better.
3.4. Social Networking Applications

Social networking is an upward trend in today’s daily life and a key element of the future’s communication methods. The majority of this young generation is already adapted to social media and new generations are born with it. Many people are using social networking tools and technologies only for fun. However, recent applications show that governmental institutions, agencies, companies, and organizations have realized the potential of social networking. As stated earlier, the Recovery Act (ARRA) has funded the National Institute of Health (NIH) with $27 Million to develop social networking sites for scientists [17]. Amount of the funding verifies the importance of creating an online collaboration environment for professionals.

Although there do not currently exist any social networking applications for transportation professionals, there are many professional-social networking groups in existing social networking environments. These online environments offer professional networking to establish and improve relationships with professionals. LinkedIn is an example of a professional-social networking site. Online environments such as Mendeley increase the collaboration between professionals, especially scientists. As a combination of desktop and web-based application, Mendeley assists researchers in managing and sharing the studies they are conducting. Mendeley’s web-based application creates a research network that tracks its colleague’s studies and gives them an opportunity to find people with similar interests [59].

In addition to social networking applications, institutional webpages such as that of the Transportation Research Board (TRB) and the Institute of Transportation Engineers (ITE) create an online environment to communicate and collaborate. Webinars and online sessions facilitate interaction between professionals. Needless to
say, these progressive organizations have long been dealing with and utilizing social networking applications such as Facebook and Twitter for information dissemination and communication.

Web 2.0 has proven to be a strong communication and collaboration tool for people, organizations and government. Nevertheless, Web 2.0 is not a technology to replace the existing communication and collaboration technologies: it is one more tool to improve them. Social media is a dynamic field and requires continuous effort to monitor and operate the web applications [14]. For agencies, on-time responses and transparency increase the participation and quality of contribution.

There are some common mistakes to be considered to understand the implementation of Web 2.0:

One common mistake is the belief that “adding Web 2.0 tools and applications to websites should increase public contribution” [12]. The point to be made, however, is not that these tools should be “added” but rather that they should be used “effectively” to succeed in facilitating interaction between agencies and the public. Osimo states that without dedicated effort to encourage the participation, applications will not be sufficient. In fact, there are thousands of non-used blogs and wikis already on the web.

Moreover, according to Osimo[12], there are many risks involved with Web 2.0 technologies, which should be considered, such as destructive behavior, privacy, and security issues, and loss of control.

Another common mistake made is reproducing the application or tool instead of utilizing similar available tools which are already being used for similar goals. For instance, there is no need to establish a social networking application on an institutional website, because people are already communicating and collaborating
outside of their institutional websites by using Facebook, LinkedIn, MySpace, etc. [12], [14]. Utilizing available and popular applications and services might be more beneficial than creating (or reproducing) new ones.

“Adopting the technology” is another misunderstood point at many agencies and institutions. Only adopting the technology is not a solution or an improvement. In fact, “simply adopting the technologies, without embracing the value, will have little or negative impact” on the communication and collaboration system. Embracing the technologies and understanding the capabilities of the applications may help to use Web 2.0 tools effectively [12].

3.5. **Summary of the Chapter**

In Chapter 3, Web 2.0 applications in transportation area are presented in four categories: information dissemination, transportation planning, public collaboration and social networking. Most of transportation applications which utilize Web 2.0 are in information dissemination category. Especially, utilization of mapping mashup applications has facilitated presentation of enormous data on a visually nice and a simple map.

In transportation planning processes, Web 2.0 technologies are mostly used to facilitate public participation and collaboration to improve projects. Also, collaboration with professionals out of the agency has a positive effect on quality of the projects.

In public collaboration applications, citizens create a community to improve livability of a neighborhood, city or an area. In terms of communication and collaboration, Web 2.0 provides effective tools such as social networking applications, wikis and mashups to facilitate interaction between users.
Social networking applications are not very common in terms of transportation. However, many professionals utilize existing social networking application to communicate each other.
Chapter 4

WEB 2.0 TECHNOLOGIES AND TOOLS UTILIZATION IN TRANSPORTATION: A SURVEY

In order to increase and enhance Web 2.0 utilization, it is important to understand the current technology and Web 2.0 familiarity of transportation professionals. As an emerging technology, Web 2.0 has been begun to be utilized by transportation industry since 2004. However, the transportation professionals and agencies are still not knowledgeable about Web 2.0 and its capabilities. For this reason, a national level survey was conducted to better understand the utilization of Web 2.0 in transportation.

4.1. Objective of the Survey

The survey was conducted in order to better understand the usage of web 2.0 tools and technologies by transportation professionals and agencies. State DOT’s, MPO’s, national level transportation institutions, agencies and organizations were the target audience. The survey was aimed at gathering information from transportation professionals about their current technology familiarity, the ways Web 2.0 tools are used in transportation, the most used Web 2.0 technologies and tools in different transportation study areas, and the utilization of Web 2.0 technologies and tools at the institution, agency and organization levels.
4.2. Survey Design

4.2.1. Methodology

The survey was designed in Spring 2010 using the Qualtrics, which is employed by the University of Delaware. The survey opened on 26 April 2010, remained open for 9 weeks and closed on 27 June 2010. During these 9 weeks, the survey was completed by 137 respondents. The University of Delaware Institutional Review Board reviewed and approved the survey.

4.2.2. Participants

A total of 1080 transportation professionals from many transportation agencies across the U.S. were contacted. 1020 of them were contacted by email, and 60 of them were given by hand both at the Institute of Transportation Engineers (ITE) Mid-Colonial District Annual Meeting on April 28-30, 2010 and at the University of Delaware. A prepaid return envelope was provided to facilitate and increase the participation from ITE Meeting and University of Delaware participants. 113 responses were received by online Qualtrics survey system and 24 responses were received by mail. The 24 responses were manually entered to the Qualtrics.

4.2.3. Questionnaire

Web 2.0 Utilization Survey included 23 questions (20 multiple choice and 3 open ended). The survey was divided into three parts: General Information, Web 2.0 Awareness and Usage, and Agency Information. The General Information part had four questions which were aimed at describing the age, occupation, and organization of the participants. The second part, Web 2.0 Awareness and Usage, included eleven questions which were focused on participants’ awareness of Web 2.0, usage purposes,
the ways Web 2.0 used in transportation area, and efficiency of the tools in transportation. The main purpose of this part was to determine the profile of transportation professionals who employ Web 2.0. The third part of the survey, Agency Information Part, was composed of five questions to learn how and in what level transportation organizations, agencies or institutions of participants utilize Web 2.0. At the end of the survey, three open-ended questions were included to gather the participants’ thoughts about Web 2.0 and its future potential in transportation area.

4.3. Data Analysis

Findings of the survey are presented in three parts based on the questionnaire’s sections. Descriptive statistic methods were used to present the findings. Results and possible further analyses were discussed.

4.3.1. Participants’ Professional Experience

In the first three questions, respondents were asked to identify their profession, work area and in what type of organization they work. Respondents were allowed to choose more than one choice or write their responses in “other” boxes.

Seventy-nine of the respondents identified themselves as planners (58%), 37 engineers (27%), 19 academic (14%), and 14 researchers (10%). 26 of respondents (18%) identified themselves as belonging to another category such as designer, builder, and technician (see Figure 4.1)
The results demonstrate that transportation planners are more interested in the survey than other transportation professionals. Because Web 2.0 technologies have been increasingly used in transportation planning in recent years to facilitate transportation planning process, we can assume that the survey participation rate of transportation planners was slightly higher than others.

Figure 4.2 shows the organization types of the participants. Nearly thirty-six percent of the participants described the organization type they worked as state level organization, 28% metropolitan organization, 20% university and research center, 11% private firm, and 3% national level organization. 5% of the respondents, who chose “other”, mostly identified themselves as city or municipality employees.
The results show that participations from State level organizations and MPOs were dominant in the survey. It is important to note that state level organizations and MPOs are more in contact with the public than other institutions, organizations and agencies. At this point, their participation is crucial to demonstrate the utilization of Web 2.0.
Figure 4.3 illustrates the age profile of respondents. The majority of the participants were between 45 and 54 years old (33%). There were only 6 participants under the age 25 (4%). More than 80% of the respondents were over 35 and they are aware of the web developments from the beginning.

4.3.2. Awareness and Usage of Web 2.0

In the second part of the survey, awareness and utilization of Web 2.0 technologies and tools were asked of participants. Web 2.0 categories were provided with a couple of best known examples to ensure that participants could clearly understand the categories.

The Table 4.1 below shows the participant’s awareness of Web 2.0 technologies and tools. The majority of web 2.0 tools are known by the most of the transportation professionals. Social Networking Applications are known by all participants (100%). Collaborative Editing (95%), Photo/Video Sharing (96%), and Synchronous Conferencing (93%) were other popular applications. However, social bookmarking, tag clouds and mashups are the least known applications. It is a considerable result that 53% of the professionals were not aware of the mashup applications. Yet, this is one of the most used Web 2.0 technologies by transportation agencies. It could be possible that they do not know the name “mashup” even though they use the application.
Table 4.1 Awareness of Web 2.0 Technologies and Tools (Response Numbers)

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Aware of</th>
<th>Not Aware of</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Web-Based Applications (OpenOffice, Google Docs, etc)</td>
<td>107</td>
<td>28</td>
<td>135</td>
</tr>
<tr>
<td>2</td>
<td>Social Networking (Facebook, MySpace, LinkedIn, Twitter, etc)</td>
<td>134</td>
<td>0</td>
<td>134</td>
</tr>
<tr>
<td>3</td>
<td>Collaborative Editing (Wikipedia, WikiTravel, Intellipedia, etc)</td>
<td>127</td>
<td>6</td>
<td>133</td>
</tr>
<tr>
<td>4</td>
<td>Blogs (Fast Lane, StreetsBlog, etc)</td>
<td>120</td>
<td>13</td>
<td>133</td>
</tr>
<tr>
<td>5</td>
<td>Social Bookmarking (del.icio.us, Diigo, StumbleUpon, Faves, etc)</td>
<td>42</td>
<td>94</td>
<td>136</td>
</tr>
<tr>
<td>6</td>
<td>Photo/Video Sharing (Flickr, Slide, YouTube, Dailymotion, etc)</td>
<td>128</td>
<td>6</td>
<td>134</td>
</tr>
<tr>
<td>7</td>
<td>Content Syndication (Google reader, RSS Feeds, Podcasting, etc)</td>
<td>108</td>
<td>28</td>
<td>136</td>
</tr>
<tr>
<td>8</td>
<td>Calendaring (Google Calendar, Yahoo! Calendar, etc)</td>
<td>110</td>
<td>24</td>
<td>134</td>
</tr>
<tr>
<td>9</td>
<td>Synchronous Conferencing (Skype, Google Talk, Windows Live Messenger, etc)</td>
<td>126</td>
<td>9</td>
<td>135</td>
</tr>
<tr>
<td>10</td>
<td>Tag Clouds</td>
<td>23</td>
<td>114</td>
<td>137</td>
</tr>
<tr>
<td>11</td>
<td>Virtual games (SecondLife, Onverse, SmallWorlds, etc)</td>
<td>61</td>
<td>75</td>
<td>136</td>
</tr>
<tr>
<td>12</td>
<td>Mashups (Google transit, Walkscore, etc)</td>
<td>65</td>
<td>72</td>
<td>137</td>
</tr>
</tbody>
</table>
Usage of Web 2.0 and usage purposes were also asked of participants. Table 4.2 demonstrates the usage of Web 2.0 by transportation professionals. In total, 28% of the participants reported that they use Web 2.0 tools for personal purposes and 24% used for work purposes. 48% of the participants stated that they were not using the Web 2.0 technologies. The results point out that Web-based Applications (36%), Collaborative Editing Technologies (34%) and Calendaring Applications (32%) are the most used Web 2.0 applications in their professional work. Social Bookmarks Application (85%), Tag Clouds (94%) and Virtual Games (93%) were the least used applications by transportation professionals.
### Table 4.2 Usage of Web 2.0 Technologies and Tools (Response numbers)

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>For Personal Reasons</th>
<th>For Work Purposes</th>
<th>Not Using</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Web-Based Applications (OpenOffice, Google Docs, etc)</td>
<td>45</td>
<td>57</td>
<td>55</td>
<td>157</td>
</tr>
<tr>
<td>2</td>
<td>Social Networking (Facebook, MySpace, LinkedIn, Twitter, etc)</td>
<td>83</td>
<td>48</td>
<td>38</td>
<td>169</td>
</tr>
<tr>
<td>3</td>
<td>Collaborative Editing (Wikipedia, WikiTravel, Intellipedia, etc)</td>
<td>63</td>
<td>60</td>
<td>52</td>
<td>175</td>
</tr>
<tr>
<td>4</td>
<td>Blogs (Fast Lane, StreetsBlog, etc)</td>
<td>37</td>
<td>36</td>
<td>75</td>
<td>148</td>
</tr>
<tr>
<td>5</td>
<td>Social Bookmarking (del.icio.us, Diigo, StumbleUpon, Faves, etc)</td>
<td>10</td>
<td>8</td>
<td>101</td>
<td>119</td>
</tr>
<tr>
<td>6</td>
<td>Photo/Video Sharing (Flickr, Slide, YouTube, Dailymotion, etc)</td>
<td>94</td>
<td>44</td>
<td>33</td>
<td>171</td>
</tr>
<tr>
<td>7</td>
<td>Content Syndication (Google reader, RSS Feeds, Podcasting, etc)</td>
<td>36</td>
<td>38</td>
<td>66</td>
<td>140</td>
</tr>
<tr>
<td>8</td>
<td>Calendering (Google Calendar, Yahoo! Calendar, etc)</td>
<td>40</td>
<td>51</td>
<td>70</td>
<td>161</td>
</tr>
<tr>
<td>9</td>
<td>Synchronous Conferencing (Skype, Google Talk, Windows Live Messenger, etc)</td>
<td>56</td>
<td>45</td>
<td>53</td>
<td>154</td>
</tr>
<tr>
<td>10</td>
<td>Tag Clouds</td>
<td>4</td>
<td>3</td>
<td>105</td>
<td>112</td>
</tr>
<tr>
<td>11</td>
<td>Virtual games (SecondLife, Onverse, SmallWorlds, etc)</td>
<td>8</td>
<td>0</td>
<td>111</td>
<td>119</td>
</tr>
<tr>
<td>12</td>
<td>Mashups (Google transit, Walkscore, etc)</td>
<td>24</td>
<td>31</td>
<td>77</td>
<td>132</td>
</tr>
</tbody>
</table>
There are three ways to utilize Web 2.0 technologies: creating content, improving content and using content. Users can create and design the content such as providing content to a web page, wiki or blog, or uploading photos and videos to these pages. The second way is providing comments and reviews to others’ posts, pages, blogs, wikis, photos or videos. In this way, participants improve the content by contribution. Another way is browsing user-generated content which means simply viewing the materials provided through the web. From the survey results, only 6 percent of the transportation professional stated that they were providing comments and reviews to others’ materials. 39 respondents (31%) stated that they are forming and designing the content. 77 of the respondents (62%) were only viewing the content provided. One important point from these results is that transportation professionals are not contributing to each other’s studies to improve them.

Figure 4.4 Ways of Using Web 2.0 Technologies and Tools
Figure 4.5 Effectiveness of Web 2.0 on Transportation Modes
Respondents were asked to identify the effectiveness of Web 2.0 technologies and tools on transportation modes based on their experiences. In Figure 4.5, results show that about 60% of the respondents stated that Web 2.0 is more effective on Transit Services and Driving with Personal Cars. Transportation professionals indicated that Web 2.0 is less effective on pedestrian and bike modes. However, there are many Web 2.0 applications which are created by public facilitate pedestrian and bike issues.

Figure 4.6 Effectiveness of Web 2.0 on Transportation Study Areas
In addition to transportation modes, transportation study areas were also asked in the survey. As demonstrated in Figure 4.6, about 90% of the respondents found that Web 2.0 is the most effective on Public Relations and 83% of them thought that Web 2.0 is effective on Transportation Planning areas.

Participants were also asked to choose three Web 2.0 technologies and tools which have the most significant effect on various transportation areas. The results point out that the Web-based applications, Social Networking Applications, Collaborative Editing Applications, Blogs and Photo/Video Sharing Applications were found effective on most transportation areas (See Figure 4.7). Three technologies that were found effective on transportation planning are respectively: Web-based Applications, Collaborative Editing and Social Networking. In terms of public relations, the most three effective Web 2.0 technologies and tools were Social Networking, Photo/Video Sharing and Blogs.
Figure 4.7 Most Effective Web 2.0 Technologies and Tools in Different Transportation Study Areas
Respondents were also asked about usage frequency of some Web 2.0 applications. Figure 4.8 illustrates the frequency of visiting or using Web 2.0 tools and applications by transportation professionals. 68% of the professionals reported that they never use or visit transportation related mashup applications. About 38 % of the professionals visit or use institutional web pages daily. Nearly 39% reported that they never use or visit transportation related social networking pages. 36% never use transportation related collaborative editing technologies or tools.

This Figure 4.8 illustrates that many transportation professionals are not utilizing Web 2.0 technologies and tools regularly. However, once users become familiar with the applications and tools, utilization process will be easy and less time consuming. For instance, if a person utilizes Content Syndication Technologies such as RSS or Google Reader to receive information from different sources, he or she does not need to go to those information provider websites every day. RSS or Google Reader provides updates from those pages regularly. The person only needs to subscribe to the web site or service.
Figure 4.8 Web 2.0 Utilization Frequency of Transportation Professionals
In order to emphasize the advantages and disadvantages, respondents were asked to rank the benefits and risks of Web 2.0 Technologies and tools. Ranking criteria explained to respondents as 1 represents the most beneficial, 7 is the least beneficial, and 1 is the most risky, 8 is the least risky. In Figure 4.9, first three choices of the respondents represented. Most of the respondents found that “easy-to-use” and “time independency and flexibility” were the biggest advantages of Web 2.0 (30% and 26%, respectively).

In terms of risks, responses were not significantly different from each other. Low participation, low quality of contribution, manageability problems, destructive behavior of users, and privacy/security issues were found to be the most risky points of Web 2.0 utilization (See Figure 4.10).

**Figure 4.9 Advantages of Web 2.0 Technologies and Tools**
Figure 4.10 Disadvantages of Web 2.0 Technologies and Tools
4.3.3. Agency Information

In Agency Information Part, respondents were asked to provide information about Web 2.0 adaptation of their agencies or institutions. Respondents were asked whether their organizations use or are planning to use Web 2.0 technologies and tools. Figure 4.11 illustrates the results of Web 2.0 utilization in agency, institution or organization. 30% of the respondent pointed out that their agency is utilizing Web 2.0 and 7% of the respondents stated that their agency is planning to utilize Web 2.0 technologies and tools. Remaining 63% stated that they do not know about the utilization of Web 2.0 in their agency. 71 respondents reported that their organization is using web services (6%) and 41 of the respondents’ organization is using synchronous conferencing technologies and tools (3%). About 3% of respondents reported that their organization is planning to use Social Networking, Collaborative Editing Technologies and Blogs.
Figure 4.11 Web 2.0 Utilization in Respondents’ Agencies, Organizations and Institutions
In order to demonstrate the future potential of the Web 2.0 technologies and tools, respondents were asked whether their organization is investing for web technologies. The majority of the respondents (76%) stated that they do not know whether their agency is investing in Web 2.0. 20% of the respondents reported that their agencies were already investing in Web 2.0 Technologies and tools. Only 4% of the respondents stated that their agencies are planning to invest in Web 2.0 (See Figure 4.12).
Figure 4.12 Web 2.0 Investment in Respondent’s Agencies, Organizations and Institutions
Respondents were also asked to evaluate their agency’s investment. The majority of the respondents indicated that the investment was well timed (54%). However, 41% of the well-timed investment was not sufficient and 13% was redundant investment. In contrast, 24% of the respondents stated that the investment was not well-timed nor sufficient. 16% of the respondents, who chose “other”, generally stated that they are not aware of the investment in web 2.0 in their agencies (See Figure 4.13).

![Figure 4.13 Evaluation of Agencies’ Investment in Web 2.0 Technologies and Tools](image)

To determine the reasons of utilizing Web 2.0 technologies and tools in transportation, respondents were asked to specify the purposes of the Web 2.0 utilization in the agency. Most of the respondents stated that Web 2.0 has been utilized for Information Dissemination (92%). Moreover, encouraging public involvement,
and providing maps, documents, data, were stated by 54% and 53% of the respondents, respectively. Only 9% of the respondents reported that Web 2.0 has been utilized for Social Interaction in their agencies.

Figure 4.14 Usage of Web 2.0 Technologies and Tools in Transportation Agencies

4.4. Results

The survey results demonstrate that most of Web 2.0 technologies and tools are known by transportation professionals. Social Networking Applications
(100%), Collaborative Editing (95%), Photo/Video Sharing (96%), and Synchronous Conferencing (93%) were the most known applications by participants. Additionally, Social Bookmarking (31%), Tag Clouds (17%), Virtual Games (45%) and Mashup applications (47%) were the least known applications. In terms of utilization of Web 2.0, 48% of the respondents stated that they are not using Web 2.0 technologies and tools neither personal nor professional purposes. Only 24% of the respondents stated that they are utilizing Web 2.0 for work purposes.

In terms of transportation modes and services, Web 2.0 technologies and tools were found more effective on “transit services” and “driving with personal cars”. Also, “transportation planning”, “transportation education” and “public relations” areas were found more related to Web 2.0 technologies and tools.

Frequency of Web 2.0 utilization was also asked of participants. 68% of the respondents reported that they never use or visit transportation related mashup applications. However, especially mapping mashup applications are one of the important element of transportation studies. In terms of usage frequency, institutional web pages were the only regularly visited web application by transportation professionals (38%, daily visit).

In terms of agencies, most of the respondents stated that they were not aware of agency’s Web 2.0 utilization and investment. 30% of the respondents stated that their agencies are utilizing Web 2.0 and 20% stated that their agencies are investing on Web 2.0. Additionally, 24% of the respondents indicated that the investment was well-timed and sufficient.
4.5. **Summary of the Chapter**

In this Chapter, result of the survey (Usage of Web 2.0 Technologies and Tools) are presented and discussed. Descriptive statistic methods were used to present the results of the survey. Transportation professionals’ Web 2.0 awareness and utilization were mainly presented with the results of the survey. Also transportation agencies’ Web 2.0 utilization was mentioned in the discussions.
Chapter 5

COMMUTER INFORMATION SYSTEM (CIS): WEB 2.0 UTILIZATION IN CONGESTION MANAGEMENT

Congestion is one of the biggest threats to the world’s economy and people’s daily lives and has dramatically increased in the last two decades. Cost of congestion in America is about 3.7 billion hours of lost work time, 2.3 billion gallons of fuel on roadways and $200 billion of wasted money every year [60]. It is quite clear that, the negative effects of congestion have been influencing governments, transportation agencies, and the public economically and healthwise.

Advanced technology has a positive effect on relieving the congestion. Today, it is possible to collect real-time traffic information by traffic monitoring sensors, traffic cameras, Electronic Toll Collection (ETC) systems, cell phone stations, and GPS/Bluetooth-enabled mobile phones. The challenge remains, however, in disseminating real-time information to drivers in the vicinity of congestion.

In this study, a hybrid system called Commuter Information system (CIS) is proposed to create a communication and collaboration structure for daily commuters. The purpose of the CIS is to disseminate real-time traffic information to daily commuters about their routes by utilizing information and communication technologies and social networking tools. CIS consists of three parts: traffic information database, commuter information database and social networking application. The traffic information database collects and stores real-time traffic data; the commuter information database collects and stores commute data of individuals
(commute time, dates, hours, preferred communication methods, etc.); and the social networking application creates an online environment to facilitate communication and collaboration between commuters and system operators. In this chapter, a theoretical framework of the CIS is presented.

5.1. **Commuter Information System (CIS)**

Recent developments in traffic information provider web sites and services such as Google Maps, Bing Maps and Traffic.com increased the utilization of real-time traffic information for trip planning. However, as a dynamic system, traffic changes fast, and most drivers are not able to check real-time traffic information while driving. The goal of the web-based commuter information system is to inform drivers about current and expected traffic conditions on the roadways.

Objectives of the Commuter Information System (CIS) are:

- Improving the traffic information services by providing timely and accurate information to daily commuters
- Encouraging the public to share travel and commute information for congestion management and provide data for transportation planning agencies
- Creating an online environment to enhance communication and collaboration between drivers and transportation authorities.
- Improving the overall reliability of web-based applications in transportation

5.1.1. **CIS - Traffic Information Database**

State DOT’s Transportation Management Centers (TMCs) have already been obtaining real-time traffic information and disseminating this information via
web-sites, 511 services, dynamic message signs, and local media organs (TVs and radios). In recent years, there has been an increase in availability of real-time traffic information due to the advances in technology, and this availability facilitates the decision-making process for both transportation authorities and individual drivers. Locally, the Delaware Department of Transportation (DelDOT) is working to provide real-time traffic volume data for highways and major arterials in the near future.

Traffic Information Databases will receive and store all traffic information that TMCs might utilize for either informing drivers or using in further studies. Work zone data and information, effects of the work zone to the nearby roads, recurring congestion segments, congestion caused by special events, and expected weather conditions are some of the information that could probably be known and predicted by TMCs. Possible effects of these situations could be used to inform drivers. Non-recurring congestions such as accidents, earthquakes, hurricanes, and emergency situations are only known by the support of the real-time traffic information receivers, monitoring systems, and through cross-agency collaboration. On this point, communication between police departments, emergency services and TMCs plays a critical role in informing people and relieving the congestion.

In addition to disseminating information to improve the movement of the traffic, traffic information databases also facilitate the transportation planning process. Real-time traffic information and data collected by sensors, traffic cameras, Electronic Toll Collection (ETC) systems, cell phone stations, and GPS/Bluetooth-enabled mobile phones provide massive data to transportation planning agencies for enhanced transportation planning.
5.1.2. CIS - Commuter Information Database

Commuter information databases receive, appropriately tag, and store the commute data of individuals to make them organized and accessible in case of need. Databases will be built by the contribution of commuters. Information will be requested from commuters on two different levels: basic information and detailed information. The basic information only includes commute information (commute days, time and routes) and preferred communication method. The detailed information will vary depending on the transportation authority’s preferences to create or improve the Origin-Destination (OD) matrix which is currently the basic element of the transportation planning studies. To expand the participation, detailed information will not be required. However, commuters will be encouraged to enter detailed information to provide data for increasing the accuracy and efficiency of the transportation planning studies.

For example, a person who lives in Elkton, MD and works in Wilmington, DE and who mostly uses I-95 to drive to and from work can enter his/her commute information in two different ways:

- Either by entering information for the required fields only (Basic Information):
  - Commute days: all weekdays
  - Origin: Elkton, MD
  - Destination: Wilmington, DE
  - Departure time: 7:15 am
  - Return time: 4:45 pm
  - Route(s): I-95, Martin Luther King Boulevard
  - Preferred communication method: Twitter
Or, by entering information for all fields (Detailed Information): In addition to the basic information, transportation agencies might request different types of information to create an OD matrix. Home and work addresses based on the TAZ level, route information, and possible activity locations after and before the commute (shopping, nursery, fitness center, etc.) could be some of the possible data points that transportation agencies may request.

In this example, the commuter will be informed about the traffic condition during the calculated commute time intervals for both I-95 and Martin Luther King Boulevard by using Twitter. Basic or detailed information will not affect types or content of information that will be sent to drivers, it only will affect the accuracy of route calculations to avoid unnecessary messages and advisories.

Information input interfaces could be designed in varying ways, depending on the technical and technological possibilities. Mapping mashup applications can facilitate information entry and increase the accuracy of data. For example, Traffic Analysis Zones (TAZs) could be tagged or place-marked on a map to enable a user to enter their origin and destination points by simply clicking on the map. Additionally, highways and major arterials could be tagged to facilitate the route information entry process. Another advantage of utilizing mapping mashups could be to provide data for an OD matrix by tagging TAZs on the map. In this way, origin and destination data will be created based on TAZ levels and will be ready to use for analysis.

Starting with the implementation of the process, Commuter Information Systems (CIS) will combine the data from the Traffic Information Database and
Commute Information Database and send alerts or advisories to drivers who are subscribed to the CIS. For example, if a police department reports an accident on a roadway, CIS will only send an alert to the drivers who are expected to use mentioned section of the roadway at that time. Also, CIS operators are able to send advisory messages to drivers such as suggested routes or expected delays, if necessary.

One of the most critical challenges of the system is deciding the appropriate tools for information dissemination. The decision for tool selection depends on the transportation agencies’ technical infrastructure, technology familiarity of potential users of the system, popularity of tools for daily usage, and availability of resources. There are many tools and technologies that can be used for information dissemination: automated phone call system, short message systems (SMS), e-mail, social networking applications (Facebook, Twitter, etc.), and mobile phone applications. Of course, there are advantages and disadvantages to each application, however, utilizing different tools and applications provides a wide variety of selection for users and might increase the contribution to the CIS.

Automated phone call systems and SMS systems require technical infrastructure for implementation, but common usage of cell phones will most likely increase the popularity and utilization of the CIS. E-mail systems are also one of the more popular communication systems that people are using, however, dependency on the internet and internet-enabled mobile phones limits accessibility to the CIS. Social networking applications are new trends of communication and provide more widespread access. Many people are communicating via social networking applications either using desktops and laptops or internet-enabled devices and mobile phones.
From a technical point of view, mobile phone applications are different than the previously mentioned communication tools. These applications can vary from simple information receiver applications to advanced route guides. An example of one of the most advanced mobile phone applications for traffic operations might be Trapster [55], which works like a navigation application and informs users visually and audibly.

5.1.3. CIS - Social Networking

The social networking component of CIS builds an online environment to create a synergy between users and operators of the system. Commuters are able to make comments, give feedback, share their experiences on the roads, and even suggest possible solutions. Although most of the commuters are not transportation professionals or experts on traffic issues, their experiences, feedback and suggestions are very important for planning, because they are users of the system. The relationship between commuters and transportation planners is foreseeable akin to that exemplified by the existing industry-scientist relationship. Such as, it is not hard to design an effective and efficient system theoretically, but if it is hard to implement or produce, it will be worthless.

Most social networking applications are user-driven environments. As a result, content of the environment, issues, topics, discussions, and products of contribution will be generated more and more as social networking applications are used. Participants will be encouraged to provide feedback about the effectiveness of the CIS, and benefits and downsides of the system. Agencies’ contributions and response times are also critical for the quality of the discussions and effectiveness of communication. Public participants should feel that their ideas, feedback and
suggestions are being considered by professionals, even if their contributions are not always applicable. The role of an agency’s participants should be to explain and clarify the concept, applications and difficulties of the system rather than only monitor the conversations. Public participants could be encouraged to share and report unexpected problems on the roadways such as unsynchronized traffic lights, pavement problems, dangerous conditions on the roadway, and many others that daily commuters might easily notice.

One important point that should be considered is that social networking applications need constant effort and input. These online communication environments are open to the public 24 hours a day, 7 days a week. At least conversations and discussions should be monitored regularly to increase the quality of the social networking component.

CIS will not be the only information dissemination system and eliminate other traffic information sources. It is an additional information system especially for daily commuters. Subscribers will be informed in case of need, so they will not need to check traffic conditions on the roadways before their trips. To achieve successful implementation, transportation agencies should utilize all possible communication techniques to reach and inform commuters about the CIS and encourage them to contribute. Institutional web pages, social networking pages and groups (LinkedIn, Facebook and Twitter), local media organs, and billboards and flyers are some possible ways to advertise the CIS.

5.2. Developing and Implementing the CIS: A Theoretical Framework

The Commuter Information System, illustrated in Figure 5.1, and a four-phase implementation system, illustrated in Figure 5.2, provides iterative steps to
develop, implement, evaluate, and modify the process of implementation. It is important to have an appropriate and well-planned model, and a cost effective allocation of resources to support the technology infrastructure, staff training, and concept design.

In Figure 5.1, CIS collects all necessary information and data from Traffic Information Databases and Commute Information Databases and sends alerts and advisory messages to the drivers. Also, users’ feedback received from CIS’s Social Networking Application will be used to improve the system and increase the efficiency. CIS might also have an effect on creating and/or improving the Origin-Destination (OD) matrix. Subscribers of the system who provide detailed information for their daily trips also provide data for OD matrix. Therefore, the Commuter Information System could be used not only as an information dissemination tool but also as a transportation planning component.
Implementation methods and processes should be precisely planned and designed for an effective and efficient use of the system. Availability of technologies, potential of staff, priorities and needs of commuters and resources should be carefully considered before implementation of the CIS. Figure 5.2 demonstrates the four-phase process of CIS implementation.
Figure 5.2  Implementation Steps of the CIS
The first phase includes steps of adopting technologies and adapting to them. In order for the CIS to be used effectively, it is important to know the capabilities of the technologies and applications employed. An evaluation of possible alternatives, advantages and disadvantages of the systems, cost of implementation and service, and future expectations needs to be considered before adopting the technologies. Staff training and concept design constitutes the second step of the Phase 1. Feedback from the professional staff on the concept will help improve the design and eliminate possible further failures.

In Phase 2, CIS will be used by transportation agencies’ employees to test the system before releasing it to the public. In this first trial phase, CIS will be monitored and evaluated by the agency. With the feedback of the users, vulnerabilities of the system will be examined to make necessary improvements.

In the first two phases, communication and collaboration between operators of the system and users will be provided via the social networking component of the CIS. Discussions between users might lead to possible solutions, different approaches and better decisions. In terms of effectiveness of the social networking component, users should be encouraged to participate.

CIS meets with the public in Phase 3 as a trial version. In this phase, a transportation agency monitors the process and applications and evaluates users’ feedback to improve the CIS concept. Familiarity with the technology that the public uses is important for the success of the implementation. Hence, information about the system and how-to-use guide should be provided to the users. CIS will be improved in a short time with the contribution of the public users, if necessary.
Phase 4 is the final version of the concept which is improved by users’ feedback. In addition to monitoring the system and evaluating users’ requests, monitoring changes in advanced technology and possible adaptation to the system will be included in Phase 4.

CIS is an information gathering and dissemination system mainly for daily commuters. Requesting commute information from daily commuters by using effective web tools and providing specific information to them about current traffic conditions before and during the commute time are two main goals of the CIS. Web 2.0, as a free web-based information dissemination and communication method, has a positive effect on CIS to increase the participation. Easy-to-use applications and popularity of social networking applications facilitate operation of the system.

5.3. Summary of the Chapter

In this chapter, a theoretical framework of the Commuter Information System (CIS) is presented. Concept map and implementation steps of the CIS are also presented. Utilization of Web 2.0 and advanced communication technologies are discussed. Lastly, the potential of CIS and additional implementations such as improving OD matrix are mentioned.
Since the early 2000s, collective intelligence has taken the driver’s seat of the communication and information technology. Web 2.0 has affected, improved and facilitated our daily life and professional interaction. As Morris et al. [14] stated, people are no more awaiting the information and entertainment coming from the screens, now they are forming their own environments. Additionally, according to O’Reilly and Battelle [8], “the Web opportunity is no longer growing arithmetically; it’s growing exponentially”. So, what is the next step? Where are we heading? How can we adapt to the new information and communication era? These are some of the questions that people are asking every day to imagine and understand the limits and boundaries of the future’s information and communication technology. But, it is obvious that the future is not so far away, it is in 2-3 years and we have already seen some of the future’s applications. O’Reilly and Battelle’s “Web squared: Web 2.0 Five Years On“ is one of the top-line articles that simply explains and describes the forthcoming communication age. They [8] described the Web 2.0 and the next step, Web Squared – which is also called Semantic Web, Web 3.0, Sentient Web, Social Web, and Mobile Web in Web literature – below:

“Imagine the Web (broadly defined as the network of all connected devices and applications, not just the PC-based application formally known as the World Wide Web) as a newborn baby. She sees, but at first she can’t focus. She can feel, but she has no idea of size till she puts something in her mouth. She hears the words of her smiling
parents, but she can’t understand them. She is awash in sensations, few of which she understands. She has little or no control over her environment.

Gradually, the world begins to make sense. The baby coordinates the input from multiple senses, filters signal from noise, learns new skills, and once difficult tasks become automatic.

The question before us is this: Is the Web getting smarter as it grows up?"

With Web 2.0 and advanced technology, devices will become sensors of our body: smartphones and cameras see and hear for us; motion and location sensors know where we are, what we are looking at and whether we are moving or not [8]. From this perspective, next generation devices and machines will be able to understand and process Web resources without human intervention [61]. More users mean more sensors and also, as these users and sensors provide data to applications and platforms, developers will be more able to deal with the “real-world problems” [8]. As Goodchild [62] says, there are six billion humans on the Earth which is six billion sensors.

In terms of transportation, Web 2.0 has already facilitated information dissemination, public participation in decision making processes, communication and collaboration; reduced dependency to the desktops and desktop applications; and expedited data and information sharing [5], [9], [10], [15]. From public relations to maintenance, operations and even major transportation planning projects, Web 2.0 has influenced all components of transportation. In terms of future potential, Web 2.0 and also Web Squared are presented in two categories: short-term potentials (1-2 years) and long-term potentials (3-5 years). It is important to understand that long-term assumptions or evaluations for the next 15-20 years might not be realistic because technology changes rapidly. The invention of the World Wide Web was about 20
years ago. In 1990, who could have known that Web will become a personal assistant of individuals in 20 years? Also, Web 2.0 is about 6-7 years old. Therefore, a 3-5 years prediction could be considered long-term.

6.1. Short-term Potentials

We have witnessed that recent web developments facilitated providing and using open-source data and governments also encouraged institutions and agencies to utilize the system. Utilization of the open-source data and applications will increase in following years; data and information will be more available and applications which use open data will explode. Welch et al. [46] stated that many local organizations would like to make most of the data they have available to everyone within systems for collaboration and cooperation. However, they emphasized that because many data are not digitally created and stored and even digitally stored data are not compatible with other software and programs, the process of data-openness is very difficult to implement. Nevertheless, advances in technology have begun to facilitate the compatibility of data resources with the creation and storage of the digital data. Schlossberg and Brehm’s [63] study, which discusses the development and implementation of two GIS-based mobile applications for public to create georeferenced local data, shows the easiness of obtaining complex data which is ready-to-use and compatible with most GIS analysis software. Osimo [12] highlights the importance of data availability and the potential of Web 2.0 in terms of utilizing it with the following statement:

“The wide availability of public data for re-use seems to be an important enabling factor for Web 2.0 application to flourish. Indeed, the managers of these initiatives agreed that wider availability of public data was their main recommendation to policy makers”.
Increasing the communication and collaboration between agencies, institutions and professionals is another potential effect of Web 2.0 and advanced web technologies in the next 1-2 years. Collaborative editing applications such as wikis and synchronous conferencing technologies such as webinars are some of the systems that facilitate interaction.

From a public relation point of view, transportation agencies have already employed Web 2.0 to increase and ease public participation in transportation planning projects. Metro’s Build Your High Capacity System, Chicago Metropolitan Planning Agency’s Go to 2040 Invent 2040 and Peer-to-plan CSS 2.0 are some of the notable applications that utilize Web 2.0 technologies and tools to facilitate the public involvement. As mentioned in Schlossberg and Brehm’s [63] study, public are even able to provide georeferenced local data such as street and sidewalk conditions, bikeability of the neighborhood and quality of the transit operations. In this point, transportation agencies will not want to miss the opportunity of cooperating with the public. Hopefully, transportation agencies will collaborate and cooperate with the public more via Web 2.0 applications in the near future.

Another possible effect of Web 2.0 could be increasing the transparency of the transportation agencies in following years. As Osimo [12] stated, transparency is one of the important changes for future governments. Web 2.0 technologies and tools which increase citizens’ awareness, facilitate public participation, provide data and information about the agency, projects and implementation processes of the projects will increase the transparency of the transportation agencies.

Transit operations have also been affected by Web 2.0 in recent years. Google Transit is one of the most known Web 2.0 mashup applications that provide
information, facilitate trip planning by transit and encourage usage of the public transit system. Although Google Transit does not cover all transit operation in the U.S., many metropolitan areas utilize the system to provide data and information to public. Google Transit included more than 446 cities’ transit information across the world as of July 2010 and the number will probably increase in the next 1-2 years. Hopefully, it will cover all transit systems of the U.S.

6.2. **Long-Term Potentials**

Potential of the assistive web technologies such as web-based decision support systems, mapping mashup applications and design tools will surely affect the transportation planning process and traffic analysis methods. Most of these web-based applications do not require software installation and do not charge for utilization of the system. These mostly free web-based applications will be more popular and used by transportation agencies in the next 3-5 years. Mapping mashup applications such as Build Your High Capacity System and SeeClickFix, sketch design tools such as Google Sketchup, and collaborative editing applications such as wiki facilitate planning process and reduce the cost of the project by eliminating the dependency on software programs.

In addition to the free web-based services, Software as a Service (SaaS) applications will be more offered in the near future. SaaS provides its applications online and does not require software installation in desktops; in this way, it minimizes technical and usage problems. It is expected that even heavy-duty computer programs will be available in the near future as a service. Citilabs’ Mint has already pointed out the change.
Rapid advances in sensor technology are introduced at the beginning of the Chapter. From this perspective, we will probably witness more automated applications, smarter devices which can understand and process the data and information [61], and information networks that components of the network can communicate to each other. It is obvious that developments in technology will increase the quality and amount of the data and information that agencies receive from sensors and traffic monitoring devices. O’Reilly and Battelle [8] indicated that Internet-enabled GPS applications – in mostly cell phones, report vehicle speed and estimate arrival time based on the traffic ahead. Also, they explained today’s and future’s traffic estimations by saying: “Today, traffic patterns are largely estimated; increasingly, they will be measured in real time”. I believe that timely and accurate real-time traffic information and data will be ordinary in 3-5 years and accessible by web tools and mobile phones. In addition to the real-time information, creation of the real-time OD matrix will be possible with advanced communication techniques.

As mentioned in Short-term Potentials, transit applications are expected to be more advanced in 3-5 years. In addition to the trip planning, real-time movements of the transit vehicles on a map, details of the vehicle (such as number of passengers, fares, advisory information, etc.), and even information about friends on-board could be available.

The Commuter Information System, which is introduced and explained in Chapter 5, will be the first step of the automated information dissemination for drivers. In the next five years, a system that monitoring devices can process and analyze the data and inform the built-in vehicle devices about the traffic condition will not be imaginary or fantasy. According to Cohn [64], a new system which is called
“high-definition traffic” has been implemented in some European countries that provides traffic information directly to the Tom Tom navigation devices in vehicles. Traffic information and data that is collected from different sources (GPS system for mobile communication networks, Tom Tom navigation devices, governmental institutions - traffic centers and historical traffic information) is used to provide real time traffic information and calculate routes based on the real time traffic.

Further, there is a high possibility that smartphones, built-in vehicle systems or any other devices that can utilize different information sources to provide possibilities will be able to make choices without your instruction. Additionally, as system used in time, devices will be familiar with the users’ lifestyle, rituals and practices, and act as a personal assistant of them. For example, if you are driving from New York to Washington D.C., your personal assistant, such as smartphone, can provide all different types of information that you need or are interested in such as: real time traffic conditions on I-95 and possible alternative routes, attraction places on your route based on your interest, restaurants that you may be interested in visiting based on your previous visits, and even your friends in a buffer zone of your travel route.

Another potential of Web 2.0 will be utilization of the virtual worlds for information dissemination, communication, education, and most importantly practices of applications. Some transportation agencies such as the Los Angeles Metropolitan Authority [39], governmental institutions, and universities such as the University of Delaware [38], have already started to utilize virtual applications.
6.3. Summary of the Chapter

Chapter 6 covered the potential of Web 2.0 and advanced Web technologies in transportation area for the near future. Possible developments and the applications were discussed in two categories: short-term potentials and long-term potentials. Effect of the possible changes in sensor technology, improved transit operations, availability of free applications and tools that could be used in transportation, and virtual worlds were some of the topics that were mentioned. In addition to the predictions of the web developers and transportation professional, personal comments and predictions were presented.
Chapter 7
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1. Summary of Findings

The Internet and Web are indispensable parts of our lives. Advanced technologies have facilitated the utilization of Internet and web sources. Beginning from the 1990s with the invention of the World Wide Web, information and communication have become easier. After a decade, Web 2.0 has changed the ways of communication by providing real-time and online interaction. Online services such as eBay and Amazon were the first sign of today’s ordinary applications in the early 2000s. Then, marketing industry and education industry have adapted this new version of the Web, Web 2.0, in the early stages. After realizing the capabilities of Web 2.0 technologies and tools, many other industries, governmental institutions, and private companies have started to utilize it.

Web 2.0 technologies and tools have been increasingly employed by the transportation industry like many of the professional industries. Especially, information dissemination, intra- and cross-agency collaboration, and public relations have become easier and faster with Web 2.0.

In this study, Web 2.0 technologies and tools, and also applications in the transportation area were presented in Chapter 2 and Chapter 3. Applications in transportation area were presented in four categories: information dissemination, transportation planning, public collaboration, and social networking. Particularly in
transportation planning category, the effect of Web 2.0 technologies and tools on transportation planning studies, public involvement in planning processes, and information providing about planning processes and projects were emphasized.

In order to understand the utilization of Web 2.0 in transportation area and current web-technology familiarity of transportation professionals, a national level survey was conducted and the results of the survey were presented in Chapter 4. Survey results demonstrated that transportation professionals are aware of current web technologies and Web 2.0; however, many of them are not utilizing these technologies and tools for transportation related purposes. 24% of the respondents mentioned that they are utilizing Web 2.0 for work purposes.

In Chapter 5, a theoretical framework was proposed to facilitate real-time traffic information dissemination for daily commuters. In the Commuter Information System (CIS), real-time traffic data which is received from traffic monitoring devices (sensors, surveillance cameras, cell phone data, etc.) is utilized to inform drivers about traffic conditions on the roadways. Web 2.0 technologies and tools facilitate the data entry process for commuters. User friendly interface and facilitating tools such as mapping mashup applications simplify and expedite the data entry process, social networking component provides communication and collaboration between commuters and system operators, and the CIS also improves the updates for and/or the creation of the origin-destination (OD) matrix for further studies.

Finally, the next step of Web 2.0, named Web Squared, Semantic Web, Web 3.0, and future potential of the current web technologies were presented in Chapter 6. Because information and communication technologies are growing rapidly,
future potential of Web 2.0 and Web Squared were explained in two categories: short term potential (1-2 years) and long-term potential (3-5 years).

7.2. Conclusions

The main goal of this study has been achieved: namely, to examine the utilization of Web 2.0 technologies and tools in transportation area. One of the main objectives of the study was to analyze the most utilized Web 2.0 technologies and tools in transportation area and their effectiveness. This objective was explained with very successful practices and applications. Especially Web-based applications, social networking, mapping mashups, collaborative editing tools, and synchronous conferencing technologies have been employed by transportation professionals and agencies. In addition to information dissemination and public relations, Web 2.0 has a significant effect on transportation planning studies. Intra- and cross-agency collaboration and public involvement in a planning process has become easier and convenient via Web 2.0. Another important contribution of Web 2.0 is facilitating real-time information and data sharing for transportation studies. Web-based mapping applications have also been positively affected from Web 2.0 technologies and tools. Powerful GIS applications and map service providers such as Google Maps and Bing Maps facilitated increased utilization of mapping mashup application even by non-expert users.

In addition to current Web 2.0 utilization in transportation area, future potential of web technologies has also been analyzed. Web 2.0 has facilitated communication and collaboration between people and sparked the interaction between humans and devices. The most significant changes will be the smart computers and devices after Web 2.0, in Web Squared. Computers will be able to process the
information and data to facilitate decision making processes. We have already seen some of these applications. For instance, advertisements in Amazon.com are generated based on web profile, interests and shopping history.

The second main objective of the study was presenting the transportation professionals’ Web 2.0 utilization profile. This objective has been met by presenting the results of a national level survey. The survey has pointed out that, although transportation professionals are aware of Web 2.0 technologies and tools, they are not utilizing them in transportation area as much. Also, results of the survey highlighted that Web 2.0 is very effective in public relations and effective in transportation planning and transportation education areas. One surprising result was that, 53% of respondents stated that they are not aware of mashup applications. However, mashups, especially mapping mashup applications, are one of the most utilized Web 2.0 applications in transportation. In this point, some respondents might be familiar with the practices but not the name.

The third objective was to investigate the effect of Web 2.0 technologies and tools on congestion management. A theoretical framework, CIS has been proposed to meet this objective. The Commuter Information System (CIS) provides real-time traffic information to daily commuters. In this system, Web 2.0 technologies and tools have been utilized to facilitate data entry and information dissemination processes. Social networking applications are aimed at providing an online environment for communication between commuters and system operators. Mapping mashup applications are also utilized to simplify data entry process.

The last objective of the study was presenting the effects of Web 2.0 technologies and tools on transportation. The study presents successfully implemented
Web 2.0 applications in transportation areas and discusses the effectiveness of applications in different places. However, Web 2.0 technologies and tools are not only effective in transportation industry but also in every part of our daily and professional lives. For this reason, the point to be considered is how effectively we are using Web 2.0 technologies and tools.

7.3. **Recommendations**

Web 2.0 is practically a new area for transportation industry; however, current utilization of Web 2.0 technologies has a great effect on transportation studies. As a rapid growing system, Web 2.0 and the next step, Web Squared, are needed to be considered by transportation industry in order to increase the benefits of the web technologies. For further studies, following future tasks are recommended:

- Effects of Web 2.0 technologies and tools on different transportation modes and areas need to be studied.
- Based on the survey results, possible methods and ways to increase the utilization of Web 2.0 by transportation professionals could be developed.
- Future potential of Web 2.0 and Web Squared could be analyzed in detail.
- In terms of Web 2.0 utilization in congestion management, Commuter Information System can be applied on a small scale to evaluate and test the system.
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<td>T. O'Reilly, &quot;What is Web 2.0.&quot;</td>
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[16] "MINT."


[22] "Cyclopath."


[26] "Fast Lane - The official Blog of the U.S. Secretary of Transportation," vol. 5.

[27] "MyBikeLane."


[29] "What is Digg?," Digg.

[30] "Maryland State Highway Administration's Channel."


[32] "RSS Syndication."

[34] "What is Dimdim?"
[35] "Tag Cloud."
[40] "Metro - Social Media - Web 2.0."
[43] "NZ Transport Agency Virtual Highway."
[48] "gCensus."
[49] "MassStats."
[50] "FlightRadar24."
[51] "Istanbul Ataturk Airport IST (LTBA) Status."
[52] "Build Your High Capacity System."
[54] "Goto2040invent2040."
[55] "Trapster."

[56] "eRideShare."

[57] "SeeClickFix About Us."


[59] "Mendeley."


Appendix A: Survey
Web 2.0 Technologies and Tools Usage in Transportation

Part 1: General Information

Q1  What is your profession? (mark all that apply)
   - Engineer
   - Planner
   - Researcher
   - Designer
   - Builder
   - Technician
   - Academic
   - Other: 

Q2  What is your study or work area? (mark all that apply)
   - Transportation Planning
   - Design and Construction
   - Operations and Management
   - Traffic Engineering
   - Infrastructure Management
   - Public Transportation
   - Energy and Environment
   - Data and Information Systems
   - Policy and Organization
   - Safety
   - Intelligent Transportation System (ITS)
   - Research and Education
   - Other:

Q3  What is your organization type? (mark all that apply)
   - State Level Institution/Agency/Organization (State DOT’s, Municipalities, etc)
   - National Level Institution/Agency/Organization (USDOT, FHWA, FTA, etc)
   - Metropolitan Organization (MPO)
   - University, Research Center, etc.
   - Private Firm
   - Other:
Part 2: Web 2.0 Awareness and Usage

Q5

Please indicate your awareness and usage of following web 2.0 technologies and tools. (mark all that apply for the "usage" part)

<table>
<thead>
<tr>
<th>Awareness Usage</th>
<th>AWARENESS</th>
<th>Usage for Personal Reasons</th>
<th>Usage for Work Purposes</th>
<th>Not Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-Based Applications (OpenOffice, Google Docs, etc)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Social Networking (Facebook, MySpace, Linkedin, Twitter, etc)</td>
<td>-</td>
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</tr>
<tr>
<td>Collaborative Editing (Wikipedia, WikiTravel, Intellipedia, etc)</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Blogs (Fast Lane, StreetsBlog, etc)</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Social Bookmarking (del.icio.us, Diigo, StumbleUpon, Faves, etc)</td>
<td>-</td>
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</tr>
<tr>
<td>Photo/Video Sharing (Flickr, Slide, YouTube, Dailymotion, etc)</td>
<td>-</td>
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</tr>
<tr>
<td>Content Syndication (Google reader, RSS Feeds, Podcasting, etc)</td>
<td>-</td>
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<tr>
<td>Calendering (Google Calendar, Yahoo Calendar, etc)</td>
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<tr>
<td>Synchronous Conferencing (Skype, Google Talk, Windows Live Messenger, etc)</td>
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<tr>
<td>Tag Clouds</td>
<td>-</td>
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<tr>
<td>Virtual games (SecondLife, Onverse, SmallWorlds, etc)</td>
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<td>-</td>
</tr>
<tr>
<td>Mashups (Google transit, Walkscore, etc)</td>
<td>-</td>
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</tr>
</tbody>
</table>

Q6

In what ways are you using web 2.0 technologies and tools in transportation?

- by providing content: creating and designing the content (providing content to a web page, wiki, blog, etc or uploading photos, videos, etc.)
- by providing comments and reviews: contributing to improve the content (making comment to other's blogs, wikis, photos, videos, etc)
- by using user-generated content: simply viewing the materials provided and contributed (not creating nor commenting)
Q7

How effective is the cost of the technologies and tools on your usage?

- I would definitely prefer free technologies and tools
- I would prefer free or inexpensive technologies and tools
- I would consider the quality of technologies and tools not the price
- I am not paying for technologies and tools

Q8

Based on your professional experience and knowledge of current technology, how effective is the Web 2.0 technologies and tools on the following transportation modes?

<table>
<thead>
<tr>
<th></th>
<th>Very Effective</th>
<th>Effective</th>
<th>Somewhat Effective</th>
<th>Neither Effective nor Ineffective</th>
<th>Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Services</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Water Services</td>
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<tr>
<td>Rail Services</td>
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<tr>
<td>Transit services</td>
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<tr>
<td>Driving with personal cars</td>
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<tr>
<td>Biking</td>
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<tr>
<td>Walking</td>
<td></td>
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</tr>
</tbody>
</table>

Q9

Based on your professional experience and knowledge of current technology, how effective is the Web 2.0 technologies and tools on the following transportation areas?

<table>
<thead>
<tr>
<th></th>
<th>Very Effective</th>
<th>Effective</th>
<th>Somewhat Effective</th>
<th>Neither Effective nor Ineffective</th>
<th>Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation Design</td>
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<tr>
<td>Transportation Maintenance</td>
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<tr>
<td>Transportation Operations</td>
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<tr>
<td>Transportation Education</td>
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<tr>
<td>Project Implementation</td>
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</tr>
<tr>
<td>Public Relations</td>
<td></td>
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</tbody>
</table>
Q10

Based on your professional experience and knowledge of current technology, please choose three Web 2.0 technologies and tools which have the most significant effect on the following transportation areas? (Choose three for each transportation area - Three for each column)

<table>
<thead>
<tr>
<th>Web-based Applications (OpenOffice)</th>
<th>Transportation Planning</th>
<th>Transportation Design</th>
<th>Transportation Maintenance</th>
<th>Transportation Operations</th>
<th>Transportation education</th>
<th>Project implementation</th>
<th>Public relations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Networking (Facebook, LinkedIn)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Collaborative Editing (Wikis)</td>
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<tr>
<td>Blogs</td>
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</tr>
<tr>
<td>Social Bookmarking (Del.icio.us)</td>
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<td></td>
</tr>
<tr>
<td>Photo/Video sharing (YouTube, Flickr)</td>
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<tr>
<td>Content Syndication (RSS, Podcasting)</td>
<td></td>
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<tr>
<td>Calendering (Google Calender)</td>
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</tr>
<tr>
<td>Synchronous Conferencing (Skype, Google Talk)</td>
<td></td>
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<td></td>
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<tr>
<td>Tag Clouds</td>
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<tr>
<td>Virtual Games (SecondLife)</td>
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<tr>
<td>Mashups (Walkscore)</td>
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<td></td>
</tr>
</tbody>
</table>

Q11

How often do you visit or use following transportation related web technologies and tools?

<table>
<thead>
<tr>
<th>Institutional web pages</th>
<th>Never</th>
<th>Less than Once a Month</th>
<th>Once a Month</th>
<th>2-3 Times a Month</th>
<th>Once a Week</th>
<th>2-3 Times a Week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation related social networking pages or groups (Facebook, LinkedIn, Twitter pages/groups, etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation related Collaborative Editing technologies or tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation related blogs</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Content syndication technologies and tools (RSS, Podcasting, etc)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation related Mashup applications</td>
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<td></td>
</tr>
</tbody>
</table>

Q12

What are your main reasons of using web 2.0 technologies and tools? (mark all that apply)

<table>
<thead>
<tr>
<th>Personal Usage (for fun or for personal reasons)</th>
<th>Transportation Related Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social interaction</td>
<td></td>
</tr>
<tr>
<td>Sharing materials</td>
<td></td>
</tr>
<tr>
<td>Dissemination of knowledge/information</td>
<td></td>
</tr>
<tr>
<td>Peer based collaboration</td>
<td></td>
</tr>
<tr>
<td>Following institutional web pages</td>
<td></td>
</tr>
<tr>
<td>Following other people's thoughts, ideas, etc</td>
<td></td>
</tr>
</tbody>
</table>
Q13 Which web 2.0 technologies and tools are you using to share information/data with your colleagues for either intra-agency or cross-agency cooperation/collaboration? (mark all that apply)

<table>
<thead>
<tr>
<th>Intra-agency cooperation</th>
<th>Cross-agency cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-Based Applications</td>
<td></td>
</tr>
<tr>
<td>(OpenOffice, Google Docs, etc)</td>
<td></td>
</tr>
<tr>
<td>Social Networking</td>
<td></td>
</tr>
<tr>
<td>(Facebook, MySpace, LinkedIn, Twitter, etc)</td>
<td></td>
</tr>
<tr>
<td>Collaborative Editing</td>
<td></td>
</tr>
<tr>
<td>(Wikipedia, WikiTravel, Intellipedia, etc)</td>
<td></td>
</tr>
<tr>
<td>Blogs (Fast Lane, StreetsBlog, etc)</td>
<td></td>
</tr>
<tr>
<td>Social Bookmarking</td>
<td></td>
</tr>
<tr>
<td>(del.icio.us, Diigo, StumbleUpon, Faves, etc)</td>
<td></td>
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<tr>
<td>Photo/Video Sharing</td>
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<tr>
<td>(Flickr, Slide, YouTube, Dailymotion, etc)</td>
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<tr>
<td>Content Syndication</td>
<td></td>
</tr>
<tr>
<td>(Google reader, RSS Feeds, Podcasting, etc)</td>
<td></td>
</tr>
<tr>
<td>Calendering</td>
<td></td>
</tr>
<tr>
<td>(Google Calendar, Yahoo! Calendar, etc)</td>
<td></td>
</tr>
<tr>
<td>Synchronous Conferencing</td>
<td></td>
</tr>
<tr>
<td>(Skype, Google Talk, Windows Live Messenger, etc)</td>
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<tr>
<td>Tag Clouds</td>
<td></td>
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<tr>
<td>Virtual games</td>
<td></td>
</tr>
<tr>
<td>(SecondLife, Onverse, SmallWorlds, etc)</td>
<td></td>
</tr>
<tr>
<td>Mashups</td>
<td></td>
</tr>
<tr>
<td>(Google transit, Walkscore, etc)</td>
<td></td>
</tr>
</tbody>
</table>

Q14 Please rank the **benefits** of using web 2.0 technologies and tools in transportation. (1: most beneficial, 7: least beneficial)

1. Easy to Use
2. Participative and Inclusive
3. Cross-Agency Cooperation/Collaboration
4. Intra-Agency Cooperation/Collaboration
5. Cost Reductive
6. Transparent
7. Time independence / Flexibility

Q15 Please rank the **risks** of using web 2.0 technologies and tools in transportation (1: most risky, 8: least risky)

1. Low participation
2. Low quality of contributions
3. Loss of control - Manageability problems
4. Destructive behavior by users
5. Privacy and security issues
6. Manipulation of content by participants
7. User profile - rate of the internet accessibility over population
8. Computer/internet dependency
### Q16
Is your institution/agency/organization using or planning to use any of these following web 2.0 technologies or tools? *(Please, mark all that apply)*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Using</th>
<th>Planning to use</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web-Based Applications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(OpenOffice, Google Docs, etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Networking Technologies and Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative Editing Technologies and Tools</td>
<td></td>
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<tr>
<td>Blogs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Social Bookmarking Technologies and Tools</td>
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<tr>
<td>Photo/Video Sharing Technologies and Tools</td>
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<tr>
<td>Content Syndication Technologies and Tools</td>
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<tr>
<td>Calendering Technologies and Tools</td>
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<tr>
<td>Synchronous Conferencing Technologies and Tools</td>
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<tr>
<td>Tag Clouds</td>
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<td></td>
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<tr>
<td>Virtual Games</td>
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<tr>
<td>Mashup Technologies and Tools</td>
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</tr>
</tbody>
</table>

### Q17
Is your institution/agency/organization investing or planning to invest in any of these following web 2.0 technologies or tools? *(Please, mark all that apply)*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Investing</th>
<th>Planning to invest</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web-Based Applications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(OpenOffice, Google Docs, etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Networking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Facebook, MySpace, LinkedIn, Twitter, etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative Editing Technologies and Tools</td>
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<td></td>
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<tr>
<td>Blogs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Social Bookmarking Technologies and Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer to peer Networking Technologies and Tools</td>
<td></td>
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<tr>
<td>Photo/Video Sharing Technologies and Tools</td>
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<tr>
<td>Content Syndication Technologies and Tools</td>
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<tr>
<td>Calendering Technologies and Tools</td>
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<tr>
<td>Synchronous Conferencing Technologies and Tools</td>
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<tr>
<td>Virtual Games</td>
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<tr>
<td>Mashup Technologies and Tools</td>
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</tbody>
</table>
Q18  Please share your opinion about the sufficiency of your institution/agency/organization's investment in the Web 2.0 technologies or tools.

- Well timed and sufficient investment.
- Well timed but not sufficient investment.
- Well timed but redundant investment.
- Sufficient but not well timed investment.
- Not well timed nor sufficient investment.
- Other:

Q19  Please identify the three technologies or tools that are most important to your institution/agency/organization in terms of following transportation improvement areas.

(Please, mark three for each column)

<table>
<thead>
<tr>
<th>Information Dissemination</th>
<th>Public Relations</th>
<th>Peer Based Professional Collaboration</th>
<th>Cross-Agency Cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web-Based Applications</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(OpenOffice, Google Docs, etc)</td>
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<tr>
<td>Social Networking Technologies and Tools</td>
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<tr>
<td>Collaborative Editing Technologies and Tools</td>
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<td>Blogs</td>
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<tr>
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<td>Photo/Video Sharing Technologies and Tools</td>
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<tr>
<td>Content Syndication Technologies and Tools</td>
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<tr>
<td>Calending Technologies and Tools</td>
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<tr>
<td>Synchronous Conferencing Technologies and Tools</td>
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<td>Tag Clouds</td>
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<td>Virtual Games</td>
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<tr>
<td>Mashup Technologies and Tools</td>
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</tbody>
</table>

Q20  What are the most important three reasons of your institution/agency/organization for using Web 2.0 technologies and tools?

(Please, mark only three)

- Information dissemination
- Social Interaction
- Providing maps, data, documents, etc
- Encouraging public involvement
- Intra-agency cooperation
- Cross-agency cooperation
- Advancing technical knowledge and providing training
- Education, workshop, tutorials, etc
<table>
<thead>
<tr>
<th>Q21</th>
<th><em>(Optional)</em> What do you think are the most effective ways of increasing the usage of web 2.0 technologies and tools by transportation professionals?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q22</td>
<td><em>(Optional)</em> What do you think about the web applications/software instead of desktop applications/software in transportation area?</td>
</tr>
<tr>
<td>Q23</td>
<td><em>(Optional)</em> What do you expect from web technologies and tools in the next 3-5 years in transportation area?</td>
</tr>
</tbody>
</table>