



A social media text analytics framework for double-loop learning for citizen-centric public services: A case study of a local government Facebook use

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ABSTRACT

This paper develops a framework for facilitating organizational learning through social media text analytics to enhance citizen-centric public service quality. Theoretically, the framework integrates double-loop learning theory with extant models of e-participation in government. Empirically, the framework is applied to a case study of citizen-to-government online interactions on a local government's department Facebook page. Our findings indicate that the missed double-loop learning opportunity resulted from two factors. First, Facebook government-posts were primarily used to advocate the government agenda by educating citizens to change their recycling behaviors without efforts to learn citizens' needs/questions. Second, this single-loop learning orientation sustained the single-loop learning nature of Facebook citizens' posts, precluding their direct and meaningful participation in the city's recycling governance. New insights generated from the case study suggest the framework's usefulness in showing more promising directions for government's double-loop learning through social media platforms to enhance public service quality.

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1. Introduction

Despite a growing body of literature on government use of social media platforms for citizen engagement (Bonsón, Torres, Royo, & Flores, 2012; Kavanaugh et al., 2012), there is a lack of research on potential roles of citizen feedback, shared insights, and effective organizational learning in enhancing the public policy-making and decision-making process through social media text analytics. This paper examines, through case study research, how a local government uses Facebook for organizational learning from social media interactions with citizens. The problem that local governments face is finding best ways to harness new digital social media platforms and make meaningful changes to public service delivery through citizen feedback.

Argyris (1976, p. 367) argued that single-loop learning encourages participants to "learn to perform as long as the learning does not question the fundamental design, goals, and activities of their organization." Hence unilateral control often accompanies advocacy, underlying single-loop learning. Against this, Argyris (1976) argued that in double-loop learning, participants are encouraged to ask questions about changing fundamental aspects of the organization. In order to

effect major change of attitude required by double-loop learning, Argyris (1976) argued that the governing variables are valid information, free, and informed choice, and internal commitment among participants.

This paper aims to make theoretical, methodological, and empirical contributions toward a better understanding of effective use of social media platforms and social media analytics for government to achieve double-loop learning which is considered to mediate enhanced citizen-centric public services. Theoretically, we have integrated double-loop learning theory (Argyris, 1976) and e-participation models (Chadwick & May, 2003; Macintosh, 2003; Reddick, 2011) to develop an Integrative Framework for Double-loop Learning through Social Media Text Analytics (DLSA) for citizen-centric public services in government through effective use of social media platforms.

Methodologically, we have developed a computational approach (i.e., social media text analytics) for determining the impact of social media pages of public services in terms of: (1) degree of citizen participation in public service delivery and (2) inherent organizational learning opportunity (i.e., whether single-loop or double-loop) for public service enhancement. Empirically, we have applied this DLSA framework being developed in this research to guide the interpretation of our case study findings of the use of Facebook to promote the city-wide recycling campaign by the City of San Antonio's Solid Waste Management Department (SWMD) in the United States. Our DLSA framework

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application is used to guide our case analysis enabling new insights and important lessons to be inferred on how learning can be incorporated in the use of social media in local governments to better provide enhanced citizen-centric public services. Data from the Facebook page of the City of San Antonio SWMD is text-mined to examine double-loop learning and e-participation. By applying this text mining methodology to citizens' concerns and sentiments toward public services in the City of San Antonio, we can determine whether single and/or double-loop learning has been used to improve public service delivery.

Theoretically, the DLSA framework integrates extant theory and models for a better theoretical explanation for shared double-loop learning. There are three e-participation models presented in the literature that are relevant to this study (Chadwick & May, 2003; Macintosh, 2003; Kamal, 2009; Reddick, 2011). The first model is the managerial, which focuses on efficient service delivery of government through e-government. The managerial model is the most passive, with little citizen participation. The second model is consultation, where citizens' input is included in the policy-making process. The third model, the highest form of e-participation, is the participatory model, which focuses on two-way interaction between government and citizens. In the participatory model, citizens' feedback can directly shape public-policy. The participatory model represents the most active form of citizen participation. All three models are examined in this study along with the theory of double-loop organizational learning first articulated by Argyris (1976).

In order to examine the utility of the proposed framework, the following two research questions are examined.

1. *How can double-loop organizational learning be facilitated to align social media use in government with the delivery of citizen-centric public services?*
2. *Does the application of the DLSA framework to government use of social media help generate insights into single and/or double-loop learning opportunities through the government use of social media?*

These research questions provide answers to the current use of social media platforms in local government for e-participation and the potential for our theory for public service improvement.

The paper is organized into five sections. The second section provides the literature review and conceptual framework that is tested in our case study. The third section provides background information on our case study of the City of San Antonio SWMD. The fourth section describes our research methodology. Our fifth section presents text-mining analysis of the Facebook page contents. Our sixth section provides a discussion of the major findings from our analysis. The final section has our conclusion, which summarizes the major research results from our case analysis, demonstrates the lessons learned, and provides future research directions.

2. Literature review and conceptual framework

2.1. Citizens, e-government, and social media

Thomas and Streib (2003) were one of the first to argue that e-government represents a new and important form of citizen-initiated contact with government. E-government is said to increase citizens' satisfaction with public service delivery (Welch, Hinnant, & Moon, 2005). Research shows that citizens who use the Internet to initiate contact with government experience higher levels of satisfaction than other more traditional contact methods such as the phone or visiting a government office (Cohen, 2006). Moreover, e-government is said to increase citizens' trust in government when they already trust government (Parent, Vandebeek, & Gemino, 2005). Further empirical research shows that trust is more likely to be increased for citizen-initiated contacts with government through e-government at the local government level, compared to the federal government level (Tolbert & Mossberger, 2006). Therefore, the importance of understanding the enabling role of

citizen engagement in e-government has been clearly demonstrated in the literature.

Social media platforms present an emerging area of citizen-initiated contacts with government. In the context of the public sector, social media can be defined as a group of technologies that allow public agencies to create greater citizen engagement (Criado, Sandoval-Almazan, & Gil-Garcia, 2013). When government uses social media platforms there are opportunities for democratic participation, coproduction, and crowdsourcing solutions and innovations (Bertot, Jaeger, & Hansen, 2012; Linders, 2012). Social media tools can provide for improvements in government transparency, policy-making, public service delivery, and knowledge management (Bonsón et al., 2012; Kavanaugh et al., 2012).

However, governments must understand the risks associated with using social media as well as the benefits of social media for public service delivery (Picazo-Vela, Gutiérrez-Martínez, & Luna-Reyes, 2012). One important risk is the increased demands made by the public, through a direct communication channel such as a Facebook page. This is especially the case when the government does not have sufficient resources to meet these demands. In contrast, the benefits for social media use in government are increased citizens' participation and engagement, promoting greater transparency, and working with citizens to develop innovative solutions to complex societal problems (Spilotopoulou, Charalabidis, Loukis, & Diamantopoulou, 2014).

Despite the potential benefits of social media use in government, however, empirical research to date primarily shows that social media is predominately used to "push" information to the public in major U.S. cities (Mossberger, Wu, & Crawford, 2013). Research also shows that most public and nonprofit human services agencies are using Facebook and Twitter as one-way communication tools to share key information about their organization (Campbell, Lambright, & Wells, 2014). However, this research shows that there are examples of government using social media to conduct some citizen interaction. Most of the activities are directed toward marketing organizational activities, raising awareness of community events, and promoting specific organizational agendas. There is limited evidence that most public and nonprofit agencies were using social media platforms for encouraging and gathering feedback from their citizens for the purpose of learning from each other, as this paper investigates.

2.2. Double-loop learning and e-participation

E-participation is defined as citizens' voluntary participation and involvement in public administration and policy through the use of web-based applications (Kim & Lee, 2012, p. 820). E-participation can serve to encourage two-way communication between government and citizens, to educate citizens, legitimize government decisions, open up the policy-making process, and provide learning opportunities (Kamal, 2009). The most important aspect of e-participation is to increase citizens' ability to participate in governance, including participation in the political process and transformation of public service delivery (Kamal, 2009; Sanford & Rose, 2007; Susha & Grönlund, 2012; Vicente & Novo, 2014). Citizens can participate with government through different channels. This multi-channel strategy can be used to improve citizen participation (Sandoval-Almazan & Gil-Garcia, 2012). E-participation applications with user-friendly designs are likely to create a positive perception of government and increase transparency and trust in government (Kim & Lee, 2012). For local governments, e-participation can be costly to operate because additional resources are required to engage citizens through the Internet which will add to the total government budget (Andersen, Henriksen, Secher, & Medaglia, 2007).

With regard to citizens' e-participation, Facebook use shows higher engagement levels of citizens with local governments, especially when they promote posts by citizens (Bonsón, Royo, & Ratkai, 2015). Research shows that citizens, when given the opportunity, are more active in engaging in discussions initiated by local governments. Research also

shows that social media can be used for crowdsourcing to engage the public in greater e-participation (Charalabidis, Loukis, & Androutsopoulou, 2014). In a study of open government maturity, e-participation is critical for the development of open government, with social media being a key dimension of increasing citizen interaction with government (Lee & Kwak, 2012).

In this paper we examine the relationship between e-participation and organizational learning which has not been explored in previous research. One important organizational learning theory is single-loop learning, which is largely based on a stimulus-response mechanism (Argyris & Schon, 1978). Argyris (1976) argued that most organizations exhibit conditions of single-loop learning and want to maintain the status quo because of organizational resistance to change. Since the routine is the proven way of getting a job done, feedback is used to correct deviations from the routine. By contrast, double-loop learning emphasizes continuous learning and experimentation, with a constant examination of the very way of defining and solving problems (Senge, 1990). Argyris (1980) argued that public administrators should work to create and facilitate double-loop learning. Double-loop learning involves questioning why an organization operates in a particular manner (Im, Porumbescu, & Lee, 2013). Double-loop learning aims to challenge and change management's mental model or theory that underlies action with a new theory or model (Kim, MacDonald, & Andersen, 2013). Double-loop learning enables organizations to be proactive in decision-making to achieve better organizational outcomes.

According to Gilson, Dunleavy, and Tinkler (2009), single-loop learning asks the questions, *Are we doing it right? Could we be doing it in more productive ways using alternative methods or approaches?* In single-loop learning, therefore, the emphasis is on improving performance incrementally and how improvements can be made to the organization. While double-loop learning asks more fundamental and hence difficult questions such as, *Are we doing the right thing? How can processes be made better?* Double-loop learning asks whether the outputs are even well aligned with the organizational goals. Single-loop learning and double-loop learning can occur at different phases of organizational growth and under different contexts.

There are some examples of the application of learning to public organizations. For instance, a case analysis of Seoul, Korea Dasan Call Center showed that the call center emphasis was on improving existing processes rather than creating new approaches, therefore, exhibiting characteristics of single-loop learning (Im et al., 2013). However, there was evidence of double-loop learning in New York State's Division of Disability Determination which conducted simulation modeling to rethink old management approaches (Kim et al., 2013). Finally, research shows mixed impacts with examples of learning in two states: Virginia shows only single-loop learning, while Vermont shows double-loop learning (Moynihan, 2005).

In general, single-loop learning is more common in traditional bureaucracies than double-loop learning (Im et al., 2013). Government organizations tend to focus on single-loop learning and do not appear to behave as innovators on any large scale (Gilson et al., 2009). When innovations occur in government, this is normally a product of responses to major external disruptions from the introduction of new technologies or greater demand from citizens for wholesale change. Single-loop learning is more applicable for routine, repetitive operations, where government goals are very clear and widely accepted (Moynihan, 2005). Double-loop learning occurs in the public sector when there is a (radical) change in the underlying assumptions and mission of the organization (Moynihan, 2005). In double-loop learning there is a questioning of the program, with a revisiting of the basic organizational mission, goals, and strategies on a regular and reoccurring basis (Shrivastava, 1983; Ventris & Luke, 1988).

Van Dooren (2011) argued that single-loop learning in government is associated with better implementation of programs to improve performance. The argument is that if organizations try harder, performance will improve. This can be done by improving the quality of performance

measurements, better leadership, taking ownership, and providing variations of integration through better coordination of programs. In contrast, for double-loop learning there is a need to be agile and adaptive to the changing environment, managing performance in alignment with the strategic goal, and better understanding of the political nature of complex decisions with tradeoffs.

Information and Communication Technologies (ICT) are viewed as an important mechanism for making closed government bureaucracies more accountable and responsive to the demands of citizens, with organizational learning as a way for citizens to more closely interact with government (Im et al., 2013). Research shows that social media networks can create high quality interactions with citizens, so government can provide ICT-enabled double-loop learning (Deng & Poole, 2008). Through ICT, learning organizations collect, retrieve, and learn from information to create superior performance (Brown & Brudney, 2003). Ultimately, double-loop learning enables the greater role of citizens and e-participation in government decision-making (Michel, 2005). The following section demonstrates models of citizen interaction with government by integrating double-loop learning, e-participation, and social media literatures.

2.3. Models of citizen interaction with E-government and organizational learning

Table 1 provides an illustration of the three models of e-participation and the important characteristics of each of the models (Chadwick & May, 2003; Macintosh, 2003; Reddick, 2011), along with the type of learning that takes place. The three models can be represented on a continuum with the managerial model being the lowest form of e-participation and the participatory model being the highest form of citizen interaction with government. The consultative model is somewhere in between the managerial and the participatory in its level of active e-participation. This research does not make the argument that governments need to work their way up through the different stages in a linear fashion, which has been criticized in previous e-government research models (Coursey & Norris, 2008). This research merely attempts to determine what factors lead to these different forms of e-participation.

2.3.1. Managerial

The managerial model of e-participation is much different from the consultative and the participatory models in that it focuses on efficiency in public service delivery (Millard, 2006). This research shows that improvements such as efficiency gains in service delivery are one of the most important aspects of e-participation. In this managerial model, citizens are viewed as "customers" and government provides information and services to satisfy the demand of their customers (Morgeson & Mithas, 2009). Therefore, the private sector term "customer" is used to mean that governments merely respond to their demands.

A primary driver of the managerial model is that the public sector should emulate the success of the private sector, which is consistent with the New Public Management (NPM) reform movement (Hood & Peters, 2004). In the NPM model, private sector principles of customers and performance are applied through the use of e-government to improve public service delivery. The managerial model is a directed model by government; therefore, information flows in one direction from government to citizens (Chadwick & May, 2003). Web 1.0 technologies have been used in the theme of NPM to create greater efficiency in public service delivery and improve business processes (McNutt, 2014). Organizational learning in the managerial model is single-loop in nature, where there is a focus on improving efficiency in service delivery and cost savings consistent with the NPM model.

In this form of participation, citizens merely use what is provided to them online by government. Governments decide and control what to put online and direct the level of one-way interaction with citizens (Pina, Torres, & Royo, 2010). E-government, through a government

Table 1

Three models of citizen interaction with e-government and type of organizational learning and use of social media.

	Level of e-participation		
	Managerial →	Consultative →	Participatory
Type of learning	Single-Loop Learning	Single-Loop Learning	Double-Loop Learning
Social media use	Social media platforms used to provide content to citizens	Social media platforms used to post information for and receive comments from citizens	Active social media use, where conversations are started by citizens and governments provide meaningful change
Role of government	Efficiency in the delivery of public services to citizens	Better policy decisions with citizen input	Citizen feedback and interaction as critical to public policy development
Role of citizens	Virtually None, treated as “customers”	Passive role	Active role
Flow of information	Directed from government to citizens; one way interaction	Directed by government but shaped by citizen input; two-way interaction	Complex with both flow from government and citizens shaping governance and policy; two-way multi-directional interaction
Common technologies used	Online tax returns, public information on websites, Facebook and Twitter used to provide content	Social media platforms used to post information for comments	Active social media use, e-voting, opinion polling, electronic town hall meetings
Logic	To enhance service delivery	To improve policy success	To enhance democratic governance
Implementation issues	Lack of cost savings	Apathy of the public	No signs of radical change

website, is typically used to solve managerial problems through creating greater efficiencies in public bureaucracies consistent with the managerial model (Chadwick & May, 2003; Dunleavy, Margetts, Bastow, & Tinkler, 2006).

Some common technologies used in the managerial form of e-participation include online tax forms, licenses, filing fees, and a social media platform such as Facebook or Twitter (Norris & Moon, 2005). Social media, such as Facebook, can be used to display content, broadcasting information to citizens. The predicted flow of information is one way, directed by government to citizens, with little interaction. Some governments provide basic forms of participation, where citizens can do research on an issue online and other governments provide more interactive e-government with the ability of citizens to conduct transactions online (Anthopoulos, Siozos, & Tsoukalas, 2007). One of the overriding issues faced in the implementation of the managerial model is the lack of cost savings as a result of online government and the difficulty in justifying investment in new technology (Pirog & Johnson, 2008).

One of the major challenges in this form of e-participation is the limited government interaction with citizens. Citizens are given the opportunity to receive information or services from government but are not able to change the public service delivery process or output. The only feedback that government receives is through their use of online services, where services that are used more often indicate greater importance to customers. A second challenge of the managerial model is that it focuses on being responsive to customers, which may not always be optimal since citizens are different from customers, given that they are interacting with a single service provider, and do not have any choice in switching providers.

2.3.2. Consultative

The consultative model is more directed toward citizens and their interaction with government than the managerial model (Kolsaker & Lee-Kelley, 2008). In this model, instead of being focused on providing more efficient service delivery to customers as emphasized in the managerial model, the role for government is directed toward creating better policy decisions with citizens' input in the decision-making process (Macintosh, 2004). Organizational learning in the consultative model is still single-loop in that feedback from citizens is not used to raise a fundamental question of whether or not what “customers” want are the right programs or public services.

There is a diverse range of actors involved in the consultative model, where there is less focus on customers and more emphasis on satisfying the interests of different stakeholders. Similar to the managerial model, the consultative model of participation is directed by government but unlike the managerial model citizens' input can potentially shape policy. Therefore, this model moves toward two-way interaction, even though it is still directed by government. In the consultative model there is a

movement away from viewing citizens as customers, in that citizens have more of a stake in governance as key stakeholders.

Some of the common technologies used in the consultative model are social media platforms such as Facebook and Twitter just to provide content and answer questions online from user comments. Social media can be used to broadcast information, but it also allows citizens to comment on and question the information. For example, government could post an update on a city government Facebook page and ask for comments. The flow of information is one direction from government to citizens, but citizens are able to respond to issues. These technologies allow for greater citizen interaction with government and are more active than just providing a Web or Facebook presence in the managerial model. The consultative model, therefore, can facilitate an improvement in public policy, with more direct citizens' input (Kolsaker & Lee-Kelley, 2008).

A notable challenge of this model is that even though citizens have been elevated from their customer status in the managerial model, information is still directed by government. Therefore, the top-down approach of information dissemination remains in the consultative model. Another challenge is that the public may not want to get involved in policy debate and a limited number of individuals and groups may ultimately drive policy changes (Shulman, 2005).

2.3.3. Participatory

The final model which has the greatest degree of citizen engagement is the participatory model. In the participatory model citizen interaction is critical for the development of public policy (Andersen et al., 2007). There is a diverse range of actors involved in the participatory model ranging from nonprofit organizations, interest groups, citizens, media, and businesses (Kakabadse, Kakabadse, & Kouzmin, 2003). Web 2.0 technologies such as active use of social media by citizens can be used for e-participation and citizen engagement in this model (Charalabidis & Loukis, 2011; McNutt, 2014). Organizational learning in the participatory model is double-loop in nature since citizens can potentially drive meaningful change and fundamentally influence policy by restructuring the public service delivery process.

Unlike the more directed managerial model, in the participatory model there is a complex flow of information between government and citizens designed to enhance and shape policy. The flow of information is multi-directional and policy changes are the result of citizens' comments (Chadwick & May, 2003). In this model, change can occur in different directions. Citizens can initiate change from the bottom up, which is not feasible in either the managerial or the consultative model. Some common technologies used in the participatory model are e-voting, online opinion polling, online town hall meetings, citizens' discussion groups, and active use of social media by citizens (Andersen et al., 2007). Social media can be used here to allow citizens to generate

comments and set items for the agenda of government to address. The flow of information is directed from citizens to government. In this model there is double-loop organizational learning, since citizens are empowered to initiate change and challenge fundamentally what government is doing.

The ultimate goal of the participatory model is to enhance democratic governance and citizen participation in governance (Macintosh & Whyte, 2008). One of the most problematic issues is that there is very little evidence for this occurring at different levels of government, and there is little known about what factors facilitate e-participation. Therefore, this study aims to investigate in the next section some of the factors that lead to greater levels of e-participation through social media text mining techniques.

2.4. Integrating government social media channels in text mining, analytics, and visualization

The proliferation of user-generated content from social media can enhance the effectiveness of policy-making by providing new insights. Areas that opinion mining in social media supports are agenda setting (online tracking of views on policy proposals), policy formation (views of citizens through sentiment mapping of the policy proposals), and implementation and evaluation (evaluation of the effectiveness of policies) (Sobkowicz, Kaschesky, & Bouchard, 2012). Social media text analytics provides new insights into the role of social media in government.

Public administrators can use e-government data by analyzing the ways that citizens verbalize their opinions in a natural language through the textual data of their comments (Stylios et al., 2010). This content can be easily collected automatically by a crawling application or manually by simply collecting comments in social media (Musto, Semeraro, Lops, & de Gemmis, 2015). This textual data can be mined for citizens' opinions according to views on subjects of interest to government. This is unlike traditional methods, such as public opinion surveys, that ask citizens standardized questions and elicit opinions on scaled questions. Text mining can be very effective at analyzing more spontaneous and revealing perceptions of citizens on policies and services.

Social media text analytics enables government to examine the formation and extinction of events, as well as users' reactions, for more effective analysis (Song, Kim, & Jeong, 2014). The large volume of social media text data has necessitated the use of automatic techniques to extract and analyze the most important information (Javed & Muralidhara, 2015). Text analytics can be used to analyze unstructured and semi-structured content and mine opinions and sentiments from the public. Social media data content and text analytics can be used to support online political participation to enhance democratic decisions in

government (Chen, Chiang, & Storey, 2012). Research shows that when government posts content on local government Facebook pages, this generated higher levels of engagement than content published by citizens on the same page. These municipality-initiated posts generated more likes, shares, and comments and sparked the most discussions (Lev-On & Steinfield, 2015).

Fig. 1 shows our conceptual framework that has integrated the key insights learned from our literature review of double-loop learning, e-participation, and social media text analytics. In this figure we show that higher levels of "participatory" citizen engagement through the social media platform in government is necessary for realizing a deeper level of shared learning or double-loop learning which may enable the government's public policy agenda and data driven (effective) decisions. In addition, an innovation in social media text data analysis method/capability is also necessary for government to shift from single-loop learning practice to social double-loop learning since they can learn from citizens in their engagement with government.

The bottom half of Fig. 1 shows the relationship between the social media channel, such as a Facebook page, and government and citizen stakeholders. The role of government in single-loop learning is to inform citizens about changes and improvements in service delivery. While in double-loop learning citizens will be sought after for feedback, new ideas, and different ways of enhancing public service delivery. In this model, social media platforms are used to enable the conversation either one directional (government to citizens) through single-loop learning or bi-directional (citizens to government and government to citizens) with double-loop learning taking place. The data that is collected from the engagement of citizens through social media with government can be analyzed through text mining analytics and visualization. The purpose of this mode of analysis is to uncover meaningful insights from the contacts that citizens and government have with each other through the government social media channel. The top half of Fig. 1 shows that single-loop learning is associated with both the managerial and consultative models as previously discussed, while the participatory model is associated with double-loop learning. The managerial and consultative models have government directing the information flows on social media to citizens, with the aim of government performance improvements, which is consistent with single-loop learning. While in the participatory model double-loop learning can occur, since the flows of information are from citizens to government as well as from government to citizens. Instead of government merely posting information on a Facebook page (managerial) or getting comments from a post (consultative), in the participatory model citizens are encouraged to freely ask questions of government on any topic of interest, including questioning why a given public service is provided in the manner observed. In this model, citizens are empowered and can question the

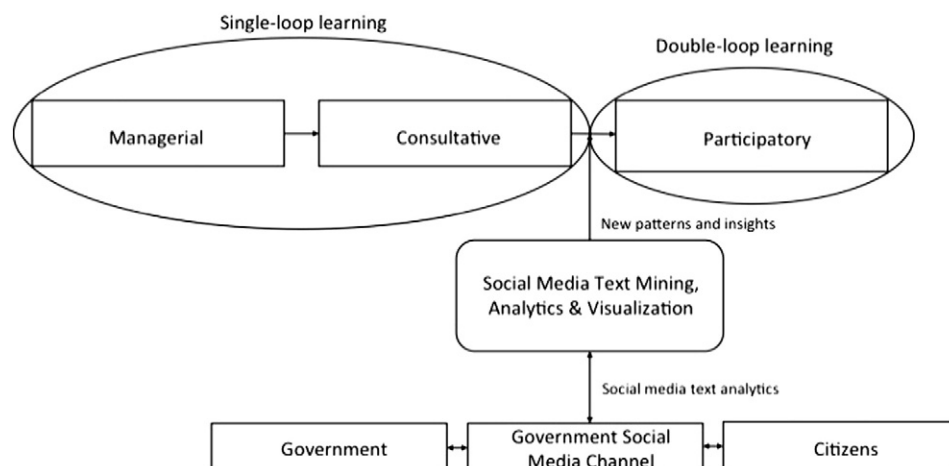


Fig. 1. Conceptual framework of using social media text mining analytics and visualization to explain double-loop learning and e-participation.

underlying assumptions of service delivery asking, can it be done differently?

Social media and text analytics innovation are required for both single-loop and double-loop learning. The key to double-loop learning is enabling participation of citizens through proactive engagement or citizen-initiated conversations and feedback. This enables governments to question the fundamentals and assumptions of services, and not merely respond to service requests as seen through the managerial model. The next section provides background information on the case that is examined to test our conceptual framework shown in Fig. 1.

3. Background: City of San Antonio Solid Waste Management Department

In this paper we adopt a case study of City of San Antonio Solid Waste Management Department use of Facebook. “The case study approach is a research strategy which focuses on understanding the dynamics present within single settings.” (Eisenhardt, 1989, p. 534) We use a single case rather than multiple cases, since we want to examine in depth the dynamics of citizens-to-government and government-to-citizens interactions on the Department’s Facebook page. Our use of a single case study is consistent with other case studies on information systems adoption and use where 60% of these studies adopted single case settings (Dubé & Paré, 2003). Our case study employs qualitative content analysis of the observations. This qualitative analysis is combined with our topic modeling approach. Both types of analysis are more thoroughly discussed in the forthcoming sections where the methodology and key findings are presented.

Our case study was undertaken in the summer of 2015. We strategically selected the City of San Antonio located in Texas, which is the 7th largest city by population in the U.S. and the 6th fastest growing city in the country. The city’s estimated population is 1,436,697 in 2014, showing a sharp population growth of 8.2% from 2010 to 2014 (QuickFacts, 2015; Wikipedia, 2015). The city is well managed with six years in a row receiving a triple A bond rating from all three major credit rating agencies.

In the context of understanding our case, we know that more than half the world’s population is now living in urban municipalities (UNEP, 2013). As cities grow economically, business activity and citizen consumption patterns tend to increase solid waste quantities. “The overall goal of urban solid waste management is to collect, treat, and dispose of solid wastes generated by all urban population groups in an environmentally and socially satisfactory manner using the most economical means available” (World Bank, 2015, p. 1). But more recently local governments in developed nations invested in technological innovations not only to provide for more cost effective solid waste management services but also to reduce, reuse, and recycle household wastes toward a vision of “zero waste”. In addition, increased urban traffic congestion reduces the productivity of the solid waste collection trucks. The problem of productivity loss is worsened by longer hauls required of the vehicles, as open landfills for disposal become scarce and located further away from urban centers. Therefore, urban municipal governments increasingly face sustainable solid waste management challenges in rationalizing solid waste management department workers and vehicles performance, while expanding solid waste programs and services to a growing urban population (World Bank, 2015).

The World Bank (2015) identifies three key success factors to sustainable solid waste management: (1) strategic planning, (2) data-driven cost analysis of solid waste options, and (3) citizen participation. For successful development and implementation of any solid waste project, a critical mass of citizens’ participation in collection, consultation on cost recovery policy, and site selection and design of recycling and landfill facilities is critically important to sustainability (Garnett & Cooper, 2014; World Bank, 2015). This paper uses the City of San Antonio SWMD as a case study on the use of Facebook to get citizens more involved in this important urban environmental issue.

3.1. The City of San Antonio Municipal Government

The City of San Antonio provides a diverse range of public services including solid waste management, public safety, public works, health services, culture and recreation, convention and tourism, urban redevelopment and housing, welfare, education, and economic development. The City of San Antonio operates not only government programs (e.g., public safety) which are funded largely by taxes (e.g., property taxes), bonds, and grants but also business-type activities which charge user fees, aiming to generating revenues from customers. The five major business-type activities are: Solid Waste Management, the Airport System, Development Services, Market Square, and Parking System (City of San Antonio, 2014). Fig. 2 below shows the relative percentage figures for the City’s FY 2014 revenues and expenses by business-type activities and by program activities. Fig. 3 indicates that the five business-type activities collectively are more cost effective than the program activities but their overall contributions to the City’s revenues are significantly less than the program activities.

3.2. City of San Antonio Solid Waste Management Department

With a budget of over \$116 million for the 2015 Fiscal Year the SWMD employs 663 employees to provide various programs and services to approximately 346,000 households (City of San Antonio, 2015, p. 1). SWMD provides the City of San Antonio “customers” (or ratepayers) with a variety of recycling and solid waste collection services, including weekly garbage collection, single-stream recycling collection, on-demand residential brush collection, residential bulky item collection, and dead animal pickup (City of San Antonio, 2015, p. 1). In addition, SWMD operates four district drop-off and processing sites for brush, bulky items, and household hazardous waste. Moreover, SWMD also operates the city’s closed landfills in compliance with the Texas Commission on Environmental Quality.

The Ten Year Recycling and Resource Recovery Plan for Residential and Commercial Services was developed by SWMD and adopted by the San Antonio City Council on June 24, 2010. While SWMD achieved 13% in FY2010 and 31% recycling rate in FY2013 through the increased recycling collection capacity through automation, city council offices advised SWMD in 2013 to revise and amend the 2010 Plan by extending the timeline for achieving the goal of recycling 60% of the single-family residential waste from 2020 to 2025 (City of San Antonio, 2013). This amendment also authorized SWMD to implement a new policy of residential subscription-based organic recycling program for a monthly subscription fee of \$3.00 and also a new policy of variable rate pricing for garbage collection starting in October 2016, which will roll out over a seven-year period (City of San Antonio, 2013).

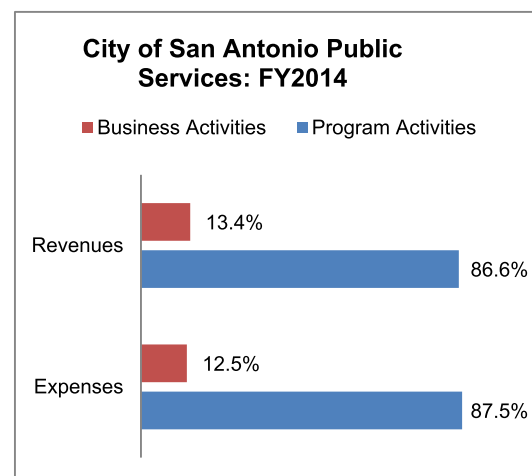


Fig. 2. San Antonio Revenues and expenses.

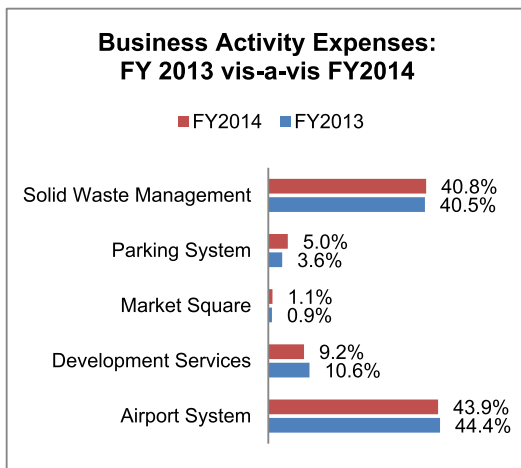


Fig. 3. Expense trend in business activities.

In 2011 SWMD spent \$470,000 for development of informational materials to be used for its marketing campaign “to educate residents on recycling” (City of San Antonio, 2013, p. 8). Based on a 2012 residential recycling marketing survey research, SWMD spent an additional \$700,000 to launch the “I Recycle” marketing campaign in FY2013 using a wide range of communication channels to educate the public on recycling. They include the Department’s new recycling website, social media sites, television commercials, billboards, a smartphone application, promotional news stories, and the “I Recycle” logo on recycling collection truck wraps.

SWMD has been on Facebook since 2011. Despite the 2013 “I Recycle” marketing campaign, as of September 29, 2015, the SWMD Facebook shows statistics of 1550 likes (with 134 visitors). In comparison, the City of San Antonio government employees, citizens, and residents liked and rated other government departments’ Facebook sites more favourably (the number of likes shown in *parentheses*): Police (104,983), Alamodome Stadium (31,748), Aviation (21,447), Market Square (17,195), Animal Care Services (16,940), Mayor’s Office (13,607), Fire (13,487), City Council Offices (11,005), PreK4SA (9815), Library (9576), and Parks and Recreation (8520). SWMD is one of the 46 government departments and organizations, which established an official Facebook account.

3.3. SWMD use of Facebook

Our dataset of government Facebook posts is longitudinal, dating from October 2011 to July 2015. During this period, SWMD posted a total of 796 unique posts on Facebook. In 2011 the number of SWMD Facebook posts only covers three months from October. Similarly, the number of SWMD Facebook posts in 2015 covers seven months until July. This leaves us only three years of complete data from 2012 to 2014. Fig. 4 shows that the SWMD use of Facebook peaked in 2013 with 251 (or 31.5%) posts in contrast to 173 (or 21.7%) in 2012 and 196 (or 24.6%) in 2014.

4. Research methodology: text mining of Facebook data

The City of San Antonio maintains eleven different social media platforms including Facebook, Twitter, and YouTube in its effort to have citizens connected with the government and business activities. In this paper we have focused on SWMD Facebook text data comprising posts from SWMD (G-posts), citizen comments and replies (C-posts) to G-posts and rating comments (C-ratings). Our argument is that the Facebook platform features provide the opportunity for both single and double-loop learning in organizations as described in Table 1. Specifically, a thematic analysis of the G-posts could enable SWMD to

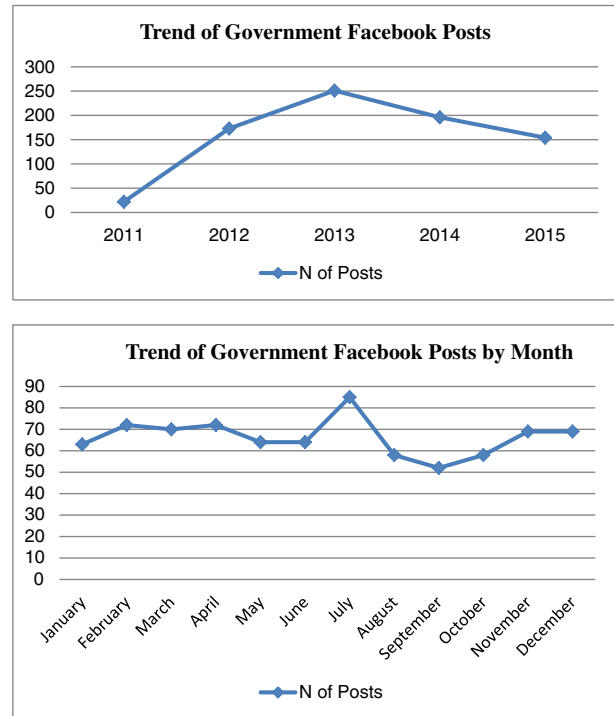


Fig. 4. SWMD Use of Facebook.

determine its implicit engagement strategy – whether managerial, consultative, or participatory. In addition, the analysis of the C-posts could reveal the information needs of residents, aspects of citizen services that do not meet citizen expectations and ideas on how to fundamentally rethink SWMD services. Consequently, consolidating insights the analysis of C-posts and G-posts could potentially inform both single-loop learning and double-loop learning at SWMD.

Concretely, in a single-loop learning framework, analysis of G-post and C-posts enables us to determine the actual engagement strategy which could be compared with the planned strategy, specific information needs of residents with respect to SWMD’s services, perceived quality of service and specific areas of discontent. From the double-loop perspective, the analyses could reveal effectiveness of the engagement strategy, suggestions on how services could be significantly improved, and alternative ways of delivering a particular service. These learning affordances and related characteristics are taken from the literature review and are provided in Table 2.

Analyzing posts on social media involves processing unstructured textual data and thus requires a qualitative approach. To address single and double-loop learning related characteristics in Table 2, we propose a two-stage text analysis framework for generating insights from the G-posts and C-posts on SWMD Facebook page. The first phase comprises the use of Computational Text Analytics tools for exploring the two datasets of posts. The exploratory phase of our analysis provides a birds-eye view of the available posts and guides the focus of the second phase – the descriptive and explanatory phase.

In the descriptive and explanatory phase, we attempt to characterise the posts into themes and explain some of the observed phenomena in the posts. A schematic diagram of our methodology is provided in Fig. 5. In the following section, we elaborate on our approach and how it helps to address organizational learning.

4.1. Exploratory text analysis

Exploratory data analysis are used in qualitative enquiries when little is known about the study domain and there are no clear research questions (Elliott & Timulak, 2005). By exploring the contents of the

Table 2
Opportunities and enabling computational methods for organizational learning.

Facebook features	Organizations learning		Typical characteristics		Applicable computational tools and methods
	Single loop learning	Double loop learning	Single Loop	Double loop learning	
Public Post from Agency and comments to agency posts Review comments and Ratings	Implicit engagement strategy Knowledge about the information needs of residents with respect to the services Knowledge about aspects of services that that need to be improved Information about the perceived quality of service recipient and level of satisfaction	Effectiveness of messages to residents on services Knowledge of suggested ideas for improving service delivery processes Knowledge of additional service needs	Resident satisfaction with services Residents know about services Residents have questions about services What services residents like the most and least Suggestions from the public on how processes can be made more efficient	Residents suggesting new ways or processes of delivering the existing services Residents suggesting other services beyond what is being provided Messaging is effective in meeting the information needs of residents	Entity recognition and linking to identify top locations, organizations and other entity types (e.g. specific waste products) mentioned in the posts and comments Topic Modeling of posts and comments to determine nature of messages exchanged and identify core topics characterizing these contents Citizen comments to determine service satisfaction level and aspects of services that are should be improved

concept of interest with no specific goals in mind; the researcher is open to learn more about interesting emerging features of the contents (Baxter & Jack, 2008). In our study we employed a number of computational methods to explore the G-posts and C-posts. Computational methods enable the collection, extraction, processing, mining, and visualization of social media and other forms of data (King, Li, & Chan, 2009). Text mining is a class of computational methods which enables the identification of important entities from text, relationships among extracted entities, and determination of sentiments or opinions associated with entities of interest (Hassan & Ojo, 2014). Text mining in the government domain facilitates the identification of emerging societal trends and analysis of public reactions to policies and public services. In our case, we use text-mining techniques on solid waste management topics and comments posted by SWMD and the public on SWMD's Facebook page which were collected in August 2015. Three text mining techniques were employed as part of the exploratory phase to know: 1) the key persons, locations, organizations, and services mentioned in the public posts; 2) the keywords describing the domain; and 3) the different topics discussed in the posts. The specific techniques are explained below.

4.1.1. Entity extraction and linking

Entity Recognition involves identification of names (nouns) in text and associating the names with a specific type such as Person, Location, Organization, Movies, Products, and so forth. (Ritter, Clark, & Etzioni, 2011). Linking of the entities involves associating the discovered names with public knowledgebase and resources such as Wikipedia,¹ Freebase,² Yago,³ websites or other resources within an organization. Identifying entities in social media text helps in identifying phenomena of potential interest. In our work, we used the free version of IBM's AlchemyLanguage API⁴ to generate the Entities contained in the public comments or C-posts.

4.1.2. Keyword extraction

Keywords provide important information about the contents of a document (Liu, Pennell, Liu, & Liu, 2009). Keyword extraction involves identifying terms that describe a domain as represented by the content of the documents being processed. Extracting keywords from C-posts for instance could provide important information on what aspects of SWMD services are considered most by the public. AlchemyLanguage

was also employed for extracting domain terms or keywords from C-posts.

4.1.3. Topic modeling

Topics are groups of terms representing some latent information about a corpus. A corpus is characterized by a set of topics within each document. We generated topic models from the collected G-posts and C-posts using the R Language implementation ("topicmodel" package) using the well-known Latent Dirichlet Allocation (LDA) model. This LDA model is a probabilistic topic modeling approach which assumes that documents (C-posts in our case) exhibit multiple topics, where each topic itself is a distribution over a set of words (Blei, 2012). In our case, we generated 10 topics over the 481C-posts. To better understand the meaning of the generated topics, how prevalent each topic is, and relationships among them, we used the LDAviz tool (Sievert & Shirley, 2014). The tool also enables us to explore and visualize the generated topics to determine the degree of relevance of terms to the different topics. After generating the topics, information available on SWMD website were used to label the topics produced from G-posts and C-posts over three iterations by one of the authors. The resulting topics and associated terms revealed the themes of the inquiries and interests of San Antonio's citizens with respect to solid waste management from the public perspective (C-posts) and the themes in the messages sent out by SWMD (G-posts).

4.2. Descriptive and explanatory text analysis

The second phase of our analysis entails the use of descriptive and explanatory text analysis on the posts guided by the results from the exploratory phase. We attempt to determine the types of messages posted by SWMD to engage the public and the nature of comments by the public.

4.2.1. Content analysis of G-posts

This involved the analysis of the government posts on the SWMD Facebook page (G-posts). The goal here is first to establish the nature of the communication or messages from government to citizens. Next, this is used as a basis for characterizing the level of citizen participation afforded by the communication style and forms embodied in the government posts or messages; whether it is managerial, consultative or participatory (Reddick, 2011). Analysis of a random sample of 50 out of the 797 posts from the government revealed some basic types of messages. Additional categories were added during the "test coding" of the G-posts to the initial categories. For coding, definitions and examples were provided for the different types of message identified from the G-posts. After the test coding task, a total of 11 categories were

¹ https://en.wikipedia.org/wiki/Main_Page.

² http://wiki.freebase.com/wiki/Main_Page.

³ <https://www.mpi-inf.mpg.de/departments/databases-and-information-systems/research/yago-naga/yago/>.

⁴ <http://www.alchemyapi.com/products/demo/alchemylanguage>.

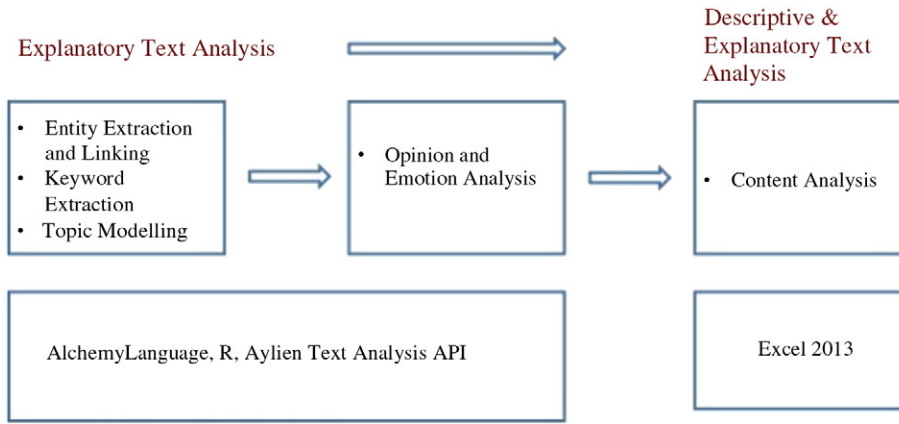


Fig. 5. Techniques for analyzing Facebook Posts for organizational learning.

identified including: Advocacy, Announcement, Congratulatory, Contest, Feedback, Freebies, Greeting, Information, Quote, Reminder and Tip.

For the actual coding exercise, three researchers familiar with government services were selected as coders. One of the authors led a session to discuss the SWMD services guided by the information on the official website of the SWMD and proceeded to explain the definitions for each of the categories. The coders applied the post categories to code each of the government posts over a period of two days without any form of discussion or communication among them. After completing the coding, a session was organized to debrief the coders on the challenges in using the provided categories as defined in Table 3. The feedback obtained from all three coders served as input into the subsequent pseudo-Delphi process for resolving all cases of disagreements between the three coders. Delphi can be characterized as a method for structuring a group communication process supported with feedbacks on individual contributions and presenting opportunities for participants to revise their views to achieve a convergence of opinion for the group as a whole (Dalkey, 1969; Okoli & Pawlowski, 2004). In our case, one of the authors led the Delphi session with all three coders as participants to discuss differences in opinions on the coding associated with the posts to obtain unanimous agreement among all three coders.

At the end of the exercise, all G-posts were assigned a category and their definitions updated which removed ambiguity.

Finally, the categories in Table 3 were mapped into the three classes of e-participation models shown in Fig. 6. Two categories of posts (Freebies and Contest) could not be aligned with the three models since they dealt with a marketing campaign for free mulch and not participation. From the post categories in Fig. 6 it does not appear to be much more than managerialism taking place in the SWMD.

4.2.2. Content analysis of C-posts

Learning from the experience of coding the G-posts, a slightly modified approach was adopted for categorising the C-posts with respect to the associated services and the nature of the comments. Only two coders were involved in the exercise with both first performing independent coding, then followed by a discussion to resolve differences to arrive at a consensus or unanimous decision. Each C-post was assigned one (or more) of the eight services described in the SWMD home page. These services include – Garbage Collection, Recycling Service, Organic Collection, Brush, Bulky Items, Hazardous Items, Special Collections, and Education.

Table 3
Definitions for categories of SWMD's posts (G-posts).

Post type	Definition	Example post	Some trigger terms by coders
Announcement	Issuance of statement about a past, current or future event	we will be by on Friday so be sure to place your cart out by 7 a.m. to prevent a missed collection.	Tomorrow, save the date, invite, on Saturday
Reminders	Message to remind citizens about recycling schedules and activities	friendly reminder: diapers are not an item that can be recycled in our program. Please do not place them in the blue recycling cart; be sure to place them in the trash.	Don't forget, friendly reminder, remember to, be sure to place your cart
Information	Factual message to help citizens toward better recycling practices	did you know? 26 to 41% of the 2.4 million tons of pet plastic discarded every year is bottled water bottles - info provided by the EPA.	Recycling fact, do you know that, attend a free workshop, for more info
Advocacy	Messages aimed at getting citizens to adopt an out-of-home waste management practice	give your empty cans and bottles at fiesta a new life by putting them in a yellow mesh recycling bag or recycling container!	Check out this video, recycle your, join the movement, donate, vote, reuse
Tips	Useful information to guide citizens towards better recycling practices	as you start buying your school supplies here is some info about eco-friendly products.	Creative ideas, an idea, tip, recycling fact, clue, consider
Quotes	Quotes related to earth, environment, and recycling	conservation is a state of harmony between men and land. - Aldo Leopold	
Congratulatory Greetings	Messages to congratulate community members Goodwill messages to community	congrats to our sapd! way to go! happy earth day!	Congrats, congratulation Happy earth day, thanks, thank you, wishing you, cute
Feedback Freebies	Request for information from citizens Distribution of free items to community members	what's filling up your recycling cart this holiday season? it's the weekend and that means free fine mulch! get yours at the nelson gardens brush recycling center tomorrow and Sunday.	Send us, have you, How to Free, mulch
Contests	Recycling related questions or quizzes for community members	today's recycling question. Glass makes up about ____% of America's municipal waste? first three correct answers - good luck!	Contest, take the test, challenge. Test, who is up

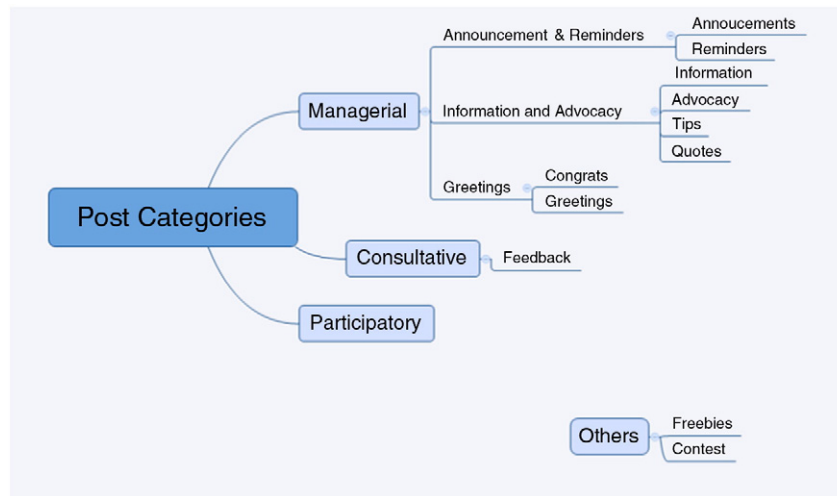


Fig. 6. Mapping post categories to the three models of participation.

5. Results of text analysis of City of San Antonio Solid Waste Management Facebook page

We present the results of our analysis of the government post and citizen comments on the SWMD Facebook page to answer the organizational learning issues discussed in Table 2. Specifically, insights on the engagement strategy of SWMD based on the nature of G-posts are presented. We examine in this section the dominant engagement strategy of SWMD, the comments citizens are posting on SWMD's Facebook page, the satisfaction of the public about SWMD services, and whether residents are making suggestions on how SWMD can improve their services in a fundamentally new way.

5.1. Engagement strategy

5.1.1. Topics extracted automatically from government posts

Through our two basic qualitative analysis techniques we attempted to describe actual engagement strategy of SWMD. As explained topic models is based on the LDA algorithm and the LDAViz were fitted for the G-posts. This was followed by a thematic categorization of messages posted by SWMD on its Facebook page. This process involves model

selection to identify the optimal term-to-topic and topics-to-document assignments. The “relevance” parameter for each topic was set to a value between 0.3 and 0.7 to produce the topics in Table 4. Topics T2 and T4 labeled “Brush Recycling Center and Free Mulch” and “Information and Reminder for Free Landfill day” are distant for the cluster of the remaining eight topics. Almost all of the remaining eight topics are related to recycling services, for example, Topics T3 on “Sending message to enquire SWMD for special item like wine bottles”, T5 on “Facts from Washington State Department Ecological Report”, T7 on “Reminder on Recycling day”, T8 about “Reminder to place cart against the curb”, “Recycling Contest” and T10 about “Recycling organic waste and garbage collection”. The predominance of recycling related topics is confirmed later based on the results of the thematic coding.

5.1.2. Types of SWMD messages posted to the public

This section presents the results of the analysis carried out on the G-posts. After analyzing the codings from three coders, the inter-rater agreement between pairs of coders is between 0.58 and 0.62 as shown in Table 5. A more formal measure of inter-rater agreement – the Cohen's Kappa measure for Coder 1 and Coder 2 (most agreeable pair) is computed as 0.54.

Table 4

Topics extracted from government posts.

No.	Topic label	Top 10 terms	% Tokens (terms comprising a topic)
T1	Reminder for free landfill disposal day on Saturday with information about address for collection center	St. Margaret Mari, quick remind, don't forget free, forget free landfill, forget free Saturday, landfill dispose day, fair ave, cute idea, collect center,	11.2%
T2	Brush Recycling Center and Free Mulch	Brush recycle center, garden brush, nelson garden brush, recycle center nelson, recycle Christmas tree, center nelson road, free premium, premium mulch, two weekends, free fine mulch	11.1%
T3	Sending enquiries to SAWMD on special items like wine bottle and diapers	Place diaper, wine bottle, us private message, send us private message, send us, answer yesterday, bubble wrap, let get ready, message address, recycle video	10.8%
T4	Information or reminder on free landfill day	Free landfill day, landfill day, citi san antonio, juli pm, divine provid cathol, landfill day Saturday, landfill day tomorrow, st Antonio solid, north star, church pm	10.5%
T5	Facts from Washington state dept ecological report	Forget put recycle, Washington state, put recycle, plastic bottle, footprint commit, favorite old, ecology report, dry cleaner, differ rememb part, dept. ecolog report	10%
T6	Mobile hazardous household waste	Info provid, mobile hhw, reusable bag, mobile hhw event, san antonio, downtown Tuesday, plastic egg, wast app, san antonian, need get	9.9%
T7	Reminder on recycling day	Collect Thursday, don't forget recycle, woodlawn lake, forget recycle, America recycle. Recycle day, woodlawn lake park, lake park, one san, one san antonio	9.7%
T8	Reminder to place cart	San antonio, forget place cart, wrap paper, forget place, don't forget place, year info, can make, info provid, don't forget, collect service,	9%
T9	Recycling contest	San antonio, don't forget, info provid, recycle garbage. Recycle contest, score recycle contest, Valentin day, score recycle, provid cbsnewscom	8.9%
T10	Recycling organic waste and garbage collection	Bag san, plastic bag, collect schedule, san antonio, bag san antonio, recycle organic recycle, organ recycle garbage, recycle organ, organ recycle, recycle garbage collect	8.8%

After employing the Delphi process to obtain unanimous agreement by all three coders, the results of the coding of G-posts show that SWMD predominantly adopts a managerial style of communication with citizens as shown in Table 1. Specifically about 92% of all posts sent out by government are managerial in nature (Fig. 7). This is made up of advocacy (17%), announcement (18%), congratulatory (1%), greetings (8%), information (23%), quote (28%), reminder (10%), and tip (11%). Examining the results in details, SWMD is very focused on providing information on waste management services in the city. Only 4% of the posts were consultation related (i.e., 4% feedback) and 4% of others.

5.2. Single loop learning

Having obtained some insights on the types of messages, we now focus our attention on learning opportunities afforded by our analyses. We consider the kind of comments posted by citizens in terms of topics they cover and their nature i.e., whether inquiries or sharing information with other users. There were 481 public posts analyzed.

5.2.1. The kinds of comments that were posted by citizens

To determine the kinds of comments made by the public in response to the SWMD posts, we started by examining the key entities and keywords that characterized public comments. By identifying entities in the public posts, SWMD could determine names of people, places, locations, and services which have been mentioned in the public comments.

We examined the topics generated from the public comments. The results revealed what was of interest to the public and the potential information needs with respect to solid waste management in the City of San Antonio (Table 6). Ten topics were identified from the C-posts based on the LDA algorithm. The ten topics ranged from recycling egg cartons (12.5% of total number of tokens obtained from all C-posts), recycling brushes (11.6%), queries and clarification for the required documents to get free mulch (11.6%), recycling bulky items (11%), recycling food packs (10.7%), recycling utensils and wrappers (9.3%), inquiries on waste containers (8.6%), container bags (7.9%) and recycling bottles (7.2%). *We infer from the ten topics that the information needs of the public are related to recycling which is also the focus of the SWMD engagement strategy.* In addition, these topics could also suggest specific areas where SWMD could do better in terms of information provision on its recycling and other services. One such area is captured by the topic on documentary evidence for the collection of free mulch.

Analysis of the relationship among the topics using LDAviz showed that while topics T4, T7 and T10 are distinct, the other topics are clustered in space signifying close semantic relations among them. What the results show is that most of the comments from citizens are responses to government programs and general information, which is consistent with the managerial model as outlined in Table 1.

Thirdly, we describe the nature of comments from the public. Fig. 8 shows different types of comments discovered through our analysis. There were a rich variety of messages posted by members of the public including: Inquiries, Replies to Inquiries, Acknowledgement, Address,

Complaint, Descriptions, Facts (e.g., about recycling), Instructions, Names, Expressions (e.g., of thanks, annoyance, exclamations), Links to Information Sources, Requests, Reply to Requests, Suggestions and Reply to Suggestions. Despite the rich diversity of comment types, about 50% of the comments were related to Inquiries (26.11%) and Replies to Inquiries (23.08%). About 3% of the comments were related to Complaints and 3.26% were about Suggestions. However there were only 0.93% of comments related to Reply to Suggestions.

Overall, these results show about half of the messages from the public are largely about their service-related information needs. It is also interesting to note that while there are really no explicit calls for suggestions from the public, a good number of suggestions have been provided by the public, albeit some of these suggestions were associated with negative experience of SWMD services.

5.2.2. Complaints about SWMD services

To provide a more detailed picture of specific issues accounting for negative sentiments associated with the four services (i.e., Brush Collection, Bulky Item Collection, Garbage and Household Hazardous Waste services), we filtered off public comments tagged with these services and classified them as negative. Table 7 shows the major complaints of the public about these categories of services. These complaints were about providing wrong addresses to the public on SWMD facilities, denial of service (multiple accounts of this), damage by SWMD agents while providing service, unprofessional conduct of SWMD agents and non-responsiveness. These issues are concrete examples of problems to be tackled by SWMD.

While all these learnings essentially take place within a single loop framework, we show by our results in the next section that opportunities for double loop learning exists for SWMD based on some of the public comments.

5.2.3. Double loop learning

The section outlines the opportunities for double-loop learning from public comments, albeit SWMD neither explicitly call for suggestions on how to improve its services nor allow the public to freely post information on its Facebook page. As indicated in Fig. 8, about 3.26% (14 comments) of the public posts were suggestive. A few of these suggestions could provide for double-loop learning. Specifically, suggestions on re-designing service related artifacts, changes to programs, service delivery process and assumptions underpinning services shown in the Table 8 were offered by the public. However, the suggestion reply or acknowledgement rate is only about 1%. Analysis of the responses provided by SWMD on the issue of battery disposal for example showed that these suggestions may not be harnessed. For instance, despite the suggestions, an agent of SWMD responded to the “battery issue” as follows:

“@Gary thanks for your comment and suggestion. Residents are encouraged to take batteries back to the permanent HHW facility or the seasonal HHW facility at 1800 Bitters. They can also take them to any of the mobile HHW events we host throughout the City...”

Table 5
Inter-rater agreement among coders.

Simple count of agreements among the three coders			
	Coder 1	Coder 2	Coder 3
Coder 1	NIL	0.6223	0.5935
Coder 2	0.6223	NIL	0.5834
Cohen's Kappa (Coder 1 & Coder 2)			
Number of observed agreements: 485 (60.85% of the observations)			
Number of agreements expected by chance: 113.2 (14.20% of the observations)			
Kappa = 0.544			
SE of kappa = 0.020			
95% confidence interval: From 0.504 to 0.583			
The strength of agreement is considered to be 'moderate'.			
(Tool: http://graphpad.com/quickcalcs/kappa2/)			

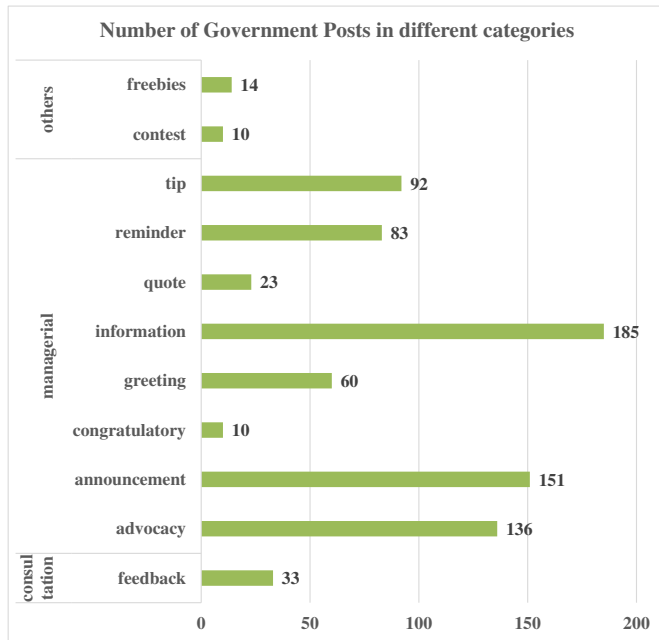


Fig. 7. Distribution of types of messages sent by government to citizens.

This could signal not only lack of double-loop learning mechanism but weak organizational learning mechanisms in general, meaning that even single-loop learning opportunities could go un-harnessed in some cases.

5.2.4. Comparison of double loop learning in two cities

Since we were not able to find strong evidence of double-loop learning in our case analysis, we provide a comparison of a city that has more effectively been able to harness Facebook for citizen engagement. We did a comparison of the City of San Antonio's Solid Waste Management Department Facebook page with the City of Austin's Resource and Recovery Facebook page. Our results showed that Austin's engagement strategy involved using Facebook more to enable double-loop learning and encourage citizen participation in governance. A comparison and examples of learning in Austin and San Antonio is found in Table 9. Austin was chosen for comparison since it won the 2015 Golden Post Award

for the use of social media and citizen engagement by the Government Social Media Conference & Expo; a major social media conference for U.S. city, county, and state governments. In addition, Austin is a neighboring city in the same state, which makes it very comparable to our case.

For example, the City of Austin's Budget Office proactively seeks out resident feedback through Facebook to gather insights about residents' priorities and preferences related to city services. Additionally, the City of Austin requested feedback with regard to citizens' level of satisfaction with these results. Through the "Dollars & Sense Austin Budget Simulator", residents are encouraged to offer feedback on the impact of taxes and fees, which is critical to public policy development. The results of the study are influential in refining the ways that the city allocates resources by determining services areas that citizens are satisfied with and value. In addition, Facebook is used for creating citizen feedback on the Zero Waste Advisory Commission.

Austin also uses a single-loop learning approach on Facebook to "push" information to the public. Several posts include content aimed at fostering awareness of community events and promoting a specific organizational agenda about zero waste. There is some evidence of citizens initiating dialogues to seek answers to their questions. Austin had fewer reviews and comments but of those few, elements of both double-loop and single-loop learning could be seen. The single-loop comments focused on satisfaction with city services whereas the double-loop comments had somewhat of an effect on changing city practices after feedback was received. In the Facebook page for Austin there are more instances of e-voting, online polling, and citizen discussion groups.

In contrast, as discussed in this paper the engagement strategy for San Antonio's Department of Solid Waste Management involves using a consultative or single-loop approach on Facebook that enables the city to receive comments from citizens. For San Antonio most of the Facebook comments were in response to the City's new policy that fines residents for not recycling properly. The single-loop learning comments were focused on clarifying questions on this program.

5.3. Summary of findings

We conclude this section by attempting to show the level of single and double-loop learning in our case study based on the results produced through the application of our methodology.

Table 6

Topics generated from citizen comments on SWMD Facebook page.

No.	Topic label	Top 10 terms	% Tokens (terms comprising a topic)
T1	Recycling egg cartons and location for free mulch	egg carton, recycle symbol, blue cart, styrofoam egg carton, can place, can recycle, fine mulch, address nelson, beer bottle, blue cart program, can food, can food wrapper, mulch waste production	12.5
T2	Recycling brush and work hours of brush centre	take brush, great job, pizza box, please send, recycle bin, abl take brush, brush center, brush bulki, brush one, bulki collect	11.6
T3	Documentary items required for obtaining for free mulch	plastic bag, cps bill, help nelson, cps energi bill, solid waste, green bin, show solid waste, bill photo, bill name, bill show solid	11
T4	Recycling bulky items like metals and broken electronics	San antonio, car fender, metal car, mulch avail, solid waste, brush pickup, broken washing machine, bring bulk	11
T5	Recycling food packs and blue cart programs	can recycle, blue cart, plastic bag, bag plastic wrap, box green, box like, cereal box, frozen veg, like cereal, milk carton	10.7
T6	Enquiries on Drop center for Apartment Complex	drop center, blue cart, hello rachel, rachel muniz antonio citi, rey issu can, apartment complex, antonio citi, apart recycling drop	10
T7	Recycling utensils and wrappers	paper towel, blue cart, bag coffee, blue chart, Chip bag coffee, plastic utensils, utensil paper, utensils, paper wrapper	9.3
T8	Waste containers	blue bin, blue cart, shrink wrap, trash can, san antonio, pay environmental fee, trash bad, water bottle, solid waste	8.6
T9	Container bags	Bag zip, bulki site, garbage pickup, neighbour tree, zip lock, bread bag, cubit yard, great news, ground park	7.9
T10	Recycling bottles	Recycle question, need removal, plastic bottle, spray bottle, top curve, toothpaste place, recycle trash bin, bag like	7.2

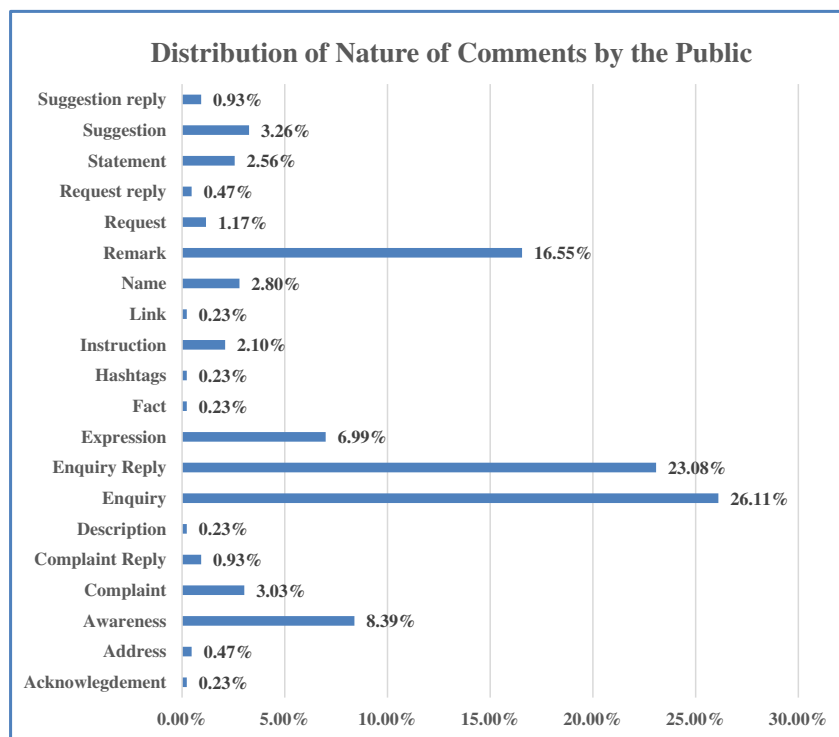


Fig. 8. Nature of public comments.

5.3.1. Single loop learning

A major goal in the SWMD plan is to increase its recycling rate which stood at 31% in FY2013. The department has also invested significant amount of resources in development of information materials for its marketing campaign on educating residents on recycling. This is clearly reflected in the messaging of SWMD to the public on its Facebook page. The education focus on recycling is clearly reflected by 23.2% of the SWMD posts are aimed at providing recycling related information. In addition the advocacy category accounted for another 17%. Similarly most of the topics; at least 6 generated from public comments were related to recycling. Therefore, one could argue that the messaging of SWMD and its comments by the public clearly reflect the emphasis and focus on recycling.

Table 7
Major SWMD complaints and examples.

Complaint type	Example
Wrong address for brush recycling center	"ONE STAR for lack of directions to Bitters Brush Recycling Center. Please RE-POST the former legal address (Bitters Rd.) and/or driving directions from Jones-Maltsberger & Starcrest ..."
Denial of service	"My regular garbage pickup is on Tuesday. My home is the only one in my neighborhood whose garbage was not picked up on 12/31. I have called 311 and they have scheduled a work order but no action has been taken. Who can help me resolve this issue?"
Denial of service	"Well seems Waste Management was not Awesome again. Missed all the trash cans at 2306 Observation Drive San Antonio TX 78227"
Denial of service	"The driver has skipped my street 2 weeks in a roll ..."
Destruction of water meter	"I am so tired of the city truck running over my water meter"
Unprofessional bin disposal practices	"Today half of the trash left in the can and spilled out on the curve ..."
Unanswered calls from citizens	"When I dial 3-1-1 the call, not go through. Is there another number to use?"

Despite the focus of SWMD on information and advocacy, inquiries still dominate the class of comments provided by the public at 26.1%. A good number of these comments continue to seek clarification on details of how to receive the services. There are also complaints on inaccurate directions on services. One could therefore conclude that SWMD could do much more to provide the public with information on how to make the best of its services. At least 3% of the public comments are related to suggestions on how SWMD can improve its services both in simple ways and fundamentally different ways.

5.3.2. Double loop learning

In terms of double-loop learning residents are suggesting new processes for delivering existing SWMD services. Some of the public comments demand re-designing SWMD recycling cans, changes to battery disposal process, and challenging fundamental assumptions by SWMD on their recycling programs. There were no public comments that indicated that residents wanted any new service not currently delivered.

Table 8
Examples of suggestions for double-loop learning.

Type	Example "unsolicited" suggestions
Re-design of recycle can	"I think it's fairly easy. Maybe we should make the trash cans smaller in size if the brown can is full what other choice do they have BUT to recycle".
Changes to program	"Do you want us to come run the machines too?? This would be a much more beneficial program if you got rid of these bags altogether!!"
Changes to Service delivery process	"Y4ou want all of San Antonio to bring their used batteries here? Not realistic. Why not collect them via the large blue collection bins? Then most of them will not show up in the area landfills."
Challenging SWMD assumptions on recycling rate	"Nice but what is the reality. Before you provided large recycling bins to all residents how many recycled? How much ended up in the landfills? The bottom line is that until you pick up the batteries 99% of them will continue to go into the landfills while the die-hard recyclers will bring the other 1% to the HHW facilities."

Table 9

Examples of Facebook and learning, comparing San Antonio and Austin.

Agency name	City of San Antonio Solid Waste Management Department		City of Austin Resource and Recovery Department	
Population	1,409,000 (2013)		885,400 (2013)	
Facebook likes	2166		2624	
Facebook reviews	61 (3.3/5 stars)		33 (4.4/5 stars)	
Requests for citizen input	0		6	
Facebook learning	Single Loop learning		Single Loop learning	Double Loop learning
Examples of posts from agency	<p>“We recently sent a notice to all City of San Antonio Solid Waste customers in order to inform residents that they could potentially be fined if they placed items such as diapers, needles, bags of trash, leaves, grass clippings or water hoses in the blue cart. We know that most residents recycle correctly. And no resident will be fined without receiving a warning notice and letter with pictures. Here is a little more explanation from a recent story with KENS 5.”</p> <p>“Want to learn more about the new Pay As You Throw program? Check out our new video that will provide you with some insights to how the program works! https://www.youtube.com/watch?v=EQMOPGI9eKM”</p>		<p>Double Loop learning</p> <p>N/A</p> <p>“Tip Tuesday: Summer is a great time to spruce up your home. If you’re planning a painting project, consider picking up Austin ReBlend. Available in 3-shades and completely FREE! Pick up yours at the Recycle & Reuse Drop-off Center. Citizen comment “Love this idea- what colors are available? Can you post photos?”</p> <p>“Austin Earth Day Festival returns for a 5th year to The Historic Browning Hanger at Mueller Saturday, April 23, from noon to 7 p.m. In addition to the great live music, be a part of the Austin Recycles aerial photo and find out which districts are crowned recycling champions of the Austin Recycles Games.” http://earthdayaustin.com/”</p>	<p>Double Loop learning</p> <p>“Austinites, do you want your recycling picked up every week? How about curbside pickup of food scraps and other organics? As we prepare to expand services we want your input. Tell us what you’re thinking by taking the survey here” bit.ly/arrservice</p> <p>“Check out this story by KVUE about Austin Resource Recovery’s stakeholder input process for Phase 2 of the Universal Recycling Ordinance. The ordinance requires affected property owners to ensure that residents, tenants, customers and employees have convenient access to recycling. ARR is seeking stakeholder input on the rules for Phase 2, which requires additional property types to offer recycling and requires that all food service establishments begin composting food wastes by 2017. Learn more and sign up to participate at http://bit.ly/UROPhase2”</p>

This could be due to the fact that the public are not able to react to posts by SWMD currently on SWMD Facebook page; residents cannot initiate a conversation. The SWMD messaging strategy does not appear to be effective at meeting the information needs of residents. A double-loop framework could be very suitable for generating options to improve SWMD messaging. For instance, providing residents with the opportunity to initiate engagement with SWMD and other residents would afford a high level of participation from the public which could spur more ideas and innovation from the public.

6. Discussion of research findings

This paper first developed a framework for examining the relationship between the use of social media, e-participation, and organizational learning in government. From this framework we performed social media text analytics on a case study of a SWMD Facebook page. The results of our analysis of the SWMD indicated that most of the interaction with citizens was one-way, directed by government toward citizens and was used primarily for improved service delivery, consistent with the managerial model. Specifically about 92% of all posts sent out by government were managerial in nature. There was only modest evidence that citizens were being consulted and requested feedback in only 4% of the posts. Essentially, our analysis showed that the City of San Antonio is currently only using Facebook in a limited and controlling way for single-loop learning.

There was evidence of an increase in the G-posts after the initial launch of the Facebook page in 2012. The topics generated by citizens were primarily focused on recycling and methods to improve self-service or co-production in achieving the zero-waste recycling goal of government. While there were a number of similar citizens' complaints on the garbage collection services, the G-posts repeatedly answered their posts with the instruction to call 311, and hence no evidence of the city using Facebook to resolve these complaints in a meaningful double-loop learning way. The findings from this study are consistent

with existing research showing that social media is typically used more to “push” information, with little meaningful changes in policy from citizen interaction with government (Mossberger et al., 2013). Social media in the SWMD is used primarily for “one-way” interaction with government on educating citizens, which also is consistent with prior research (Campbell et al., 2014). However, comparing the cities of Austin and San Antonio did find some evidence of double-loop learning for Austin's Facebook page, so the potential is there.

Our case analysis indicated single-loop learning with Facebook being primarily used for performance improvement and meeting the needs of customers, which is consistent with prior research on government organizational learning (Gilson et al., 2009; Im et al., 2013). These findings are very consistent with single-loop learning in the managerial model. The potential is there for the City of San Antonio SWMD to better integrate social media for more meaningful change and e-participation. However, presently in San Antonio Facebook is used simply to market the government recycling initiative by broadcasting information to citizens.

7. Conclusion

This paper has provided a conceptual framework that examined the role of three models of e-participation in government - managerial, consultative, and participatory - to demonstrate how local government can learn from citizens. Specifically, the conceptual framework of double-loop learning and e-participation was tested through the social media text analytics methodology in analyzing Facebook text data for a large city in the U.S. The major findings indicated that Facebook was primarily used for single-loop learning to improve department performance; there was no evidence of double-loop learning occurring through the department use of Facebook.

From our analysis there are lessons that can be learned. First, governments may choose not to have a very participatory social media strategy since they might have budgetary constraints, or they may simply choose

to direct conversations on Facebook, as our case study shows, using it for single-loop learning to only improve performance. Second, meaningful double-loop learning would involve enabling citizens to initiate their own posts and recommend courses of action to be followed up by government. As a result, policy makers can use social media for double-loop learning but must accept that they will be opened up to criticism and other citizen feedback beyond merely improving performance. Theoretically, this paper was able to provide a framework that integrates the double-loop learning theory within the context of e-participation. From this analysis, we were able to show the practical importance of governments being able to understand what they are posting on Facebook and citizens' reactions to the content which should help government formulate a better Facebook citizen engagement strategy.

There are important limitations of this study and future research directions should be mentioned. First, we are limited to analysing one city and a small sample of Facebook posts. This limits the generalizability of our initial findings to a wider context. Second, with social media text analytics there can be the problem of missing important information that cannot be categorized. Sometimes too broad and important attributes may not come through in the analysis. Despite these limitations, we viewed it as important to show how social media text-mining and analytics tools can be applied to better understand the actual use of social media in government and the learning opportunity it can provide. These tools can be easily applied to an entire city or other cities. For this paper, we believed that focusing on too many departments, or cities for that matter, would make the results not easily interpretable and meaningful. Therefore, future research could analyze a larger sample size. From these results of this case analysis we hope that more research is done on the potential of social media to interact and engage with citizens, an important factor in the development of e-government research.

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