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Collaborative data networks for public service: governance, management, and performance

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ABSTRACT

This study aims to advance the theory and practice of managing collaborative data networks for information and decision-support services that exist in over 400 US metropolitan areas. Integrating insights from collaborative governance, network management, and cross-boundary information sharing, this study develops a framework to outline the interplay between context, management, collaborative dynamics, technology, and performance. This study further utilizes the framework to conduct an exploratory in-depth case study of a metropolitan transportation data network to examine such interplay. The findings suggest ways to improve the performance of collaborative data networks and their implications are discussed.

KEYWORDS Digital government; cross-boundary information sharing; collaborative governance; network management

Introduction

In the digital government area, there is a growing need for collaborative governance across organizational boundaries to leverage technology to provide an integrated and customized view of public service (Dawes, Cresswell, and Pardo 2009). Such cross-boundary collaboration is particularly critical in a federalist administrative system for integrating data that have been collected in individual jurisdictions but need to be integrated to create a service-oriented view.

The primary research question is 'How can we govern and manage cross-boundary collaborative networks with the use of information and communication technology (ICT) to improve the performance of information and decision-support service?' This question focuses on collaborative data governance networks, which are critical to the success of generating quality information for cross-boundary public services such as transportation. Moreover, this question aims to understand the role of ICT in improving performance of such networks. To advance our understanding of collaborative data networks, this study attempts (1) to develop a conceptual framework that integrates insights from three streams of research: electronic government (e-government), collaborative governance, and network management and (2) to explore network governance and management as well as the role of ICT in achieving a high level of network performance. The link between governance, management, and

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performance has been identified as one main area of research for network management literature (O'Toole 2015).

To address the research question, this study conducted an in-depth case study of metropolitan planning organizations (MPOs) and their collaborative governance networks in metropolitan areas for transportation information and decision-support services. It is a federal mandate to establish a MPO for any metropolitan area with a population of 50,000 or above. Such MPOs manage a network of local governments for better planning. In examining these MPOs, this study's focus is on transportation data for local governments and regional entities to make planning decisions. The collection of transportation data is typically done by autonomous local jurisdictions. As a result, information sharing across jurisdictions becomes a necessity to create an integrated view of metropolitan transportation. Such transportation data also present opportunities for effective use of ICT, which aligns with the goal of this study.

The following section provides a brief description of the relevant bodies of literature on collaborative data governance networks. Then, a conceptual framework drawing from these relevant bodies of literature is outlined. Next is a discussion of research design, methods, and data. The next section provides case description, analysis, and findings. This article then discusses the practical and theoretical implications of the findings. It concludes with a summary of the main points and opportunities for future research.

Literature review

E-government literature on cross-boundary information sharing

The existing e-government literature on cross-boundary information sharing provides insight for this research. For politics and policy, Dawes, Cresswell, and Pardo (2009) articulate the need for legal authority in effective information sharing. Having an information policy is critical because policy issues tend to be the biggest barrier to successful information sharing (Dawes, Cresswell, and Pardo 2009; Yang and Maxwell 2011). Politics is central to information technology (IT) projects that span over functional areas and organizational boundaries (Hellberg and Grönlund 2013; Dawes 1996). The different interests between IT departments and other business departments, as articulated by Kraemer et al. (1989), is a source of politics.

One of the fundamental issues for effective information sharing is to develop shared values across organizations. In fact, implementation of data interoperability can be significantly hampered by conflicts in values such as the emphasis on privacy at the expense of other basic objectives of interoperability (Hellberg and Grönlund 2013). Another key organizational factor for effectiveness is past collaborative experience among organizations that speaks to the mutual trust needed for cross-boundary information sharing (Yang and Maxwell 2011). Moreover, the difference in operational procedures can also pose a barrier to successful information sharing due to the complexity and amount of negotiation involved to address these differences (Yang, Zheng, and Pardo 2012). To achieve effective information sharing, incentives constitute a key tool (Yang and Maxwell 2011).

Technology and data are also important factors in effective cross-boundary information and service collaboration (Dawes, Cresswell, and Pardo 2009; Bekkers 2007). Especially, different IT capabilities can present a challenge for information sharing

and service integration. Technical assistance and training is likely needed for those organizations and individuals lacking the prerequisite knowledge and skills to be effective participants in cross-boundary settings. For cross-boundary data sharing, issues such as variety of data definitions and formats present significant challenges for creating a meaningful and personalized view of disparate data coming from various organizations (Comfort 2007).

Collaborative governance for information service

The studies of collaborative governance have identified both the context and condition of success (Emerson, Nabatchi, and Balogh 2012; Ansell and Gash 2008). Important contextual factors include the existing policy and legal framework, levels of conflicts (trust), interdependence, incentives, and leadership (Emerson, Nabatchi, and Balogh 2012; Ansell and Gash 2008). A policy and legal framework for the governance regime provides the shared institutional foundation for collaboration (Bingham 2008). Such a framework facilitates the creation of shared understanding that is needed for inter-organizational collaboration (Wood and Gray 1991). A high level of conflict preceding the formation of a collaborative governance presents a major challenge to that collaborative governance (Emerson, Nabatchi, and Balogh 2012). The degree of interdependence is an important motivation for collaboration across organizational boundaries (Rethemeyer 2009; Rethemeyer and Hatmaker 2008). Incentives for organizational and individual participants constitute another important contextual consideration. Lastly, leadership and management are crucial for the success of collaborative governance networks (Provan and Kenis 2008).

In terms of process and dynamics of collaborative governance, Emerson, Nabatchi, and Balogh (2012) provide three main areas of activities: principled engagement, shared motivation, and capacity-building for joint action. The guiding principles for principled engagement include fair and representative participation, and discourse informed by diverse participant perspectives. Shared motivation involves the process of fostering mutual trust, shared understanding, and securing and carrying out commitment by individual participating organizations (Emerson, Nabatchi, and Balogh 2012, 13–14). Shared motivations can foster commitment that can be translated into concrete plans and actions. Capacity-building for joint action is a critical area of activities for collaborative dynamics. To build capacity, Emerson, Nabatchi, and Balogh (2012) argue for the need for institutions (procedures and arrangements), leadership, and resources to guide and effectuate joint actions at both organizational and individual levels.

Network management

Network management literature has highlighted structural characteristics to help identify relevant leadership and management activities (O'Toole 2015; Provan and Lemaire 2012). Structural characteristics include who has what operational authority, the grouping of various organizations and individuals for network governance (i.e. boards, committees), communication channels and mechanisms, and the prior history of collaboration (Agranoff 2007).

Network management matters in performance (Meier and O'toole 2001; McGuire and Silvia 2010). Specific network management activities can involve activating key

network members, mobilizing their support and commitment, framing the key issues and objectives for the network, and synthesizing the diverse interests to create a network whole (McGuire 2006, 2002). These network activities share the generic goals and objectives of network management such as building mutual trust (social capital), creating shared goals and understanding, and wide distribution of needed resources.

Network performance can be measured by result-oriented outcomes and process-oriented outcomes (Provan and Milward 2001; Chen 2008). Examples of result-oriented outcomes include the number of children in stable families through a children's service network or the number of job placements by a network of job-training organizations. Process-oriented outcomes are those dealing with increase in mutual trust, shared understanding, and social capital. These performance measures need to be in alignment with the goals and objectives of a network. Another important perspective of network performance is the level at which performance is measured. Provan and Milward (2001) argue the importance of differentiating network effectiveness at the levels of individuals, programme, and community as well as caution against the potential trade-offs between performance scores at these levels.

An integrated conceptual framework for information and decision-support networks

The development of the proposed integrated conceptual framework draws from the aforementioned bodies of literature and is adapted to networks providing information and decision-support services. The core elements are the context and initial conditions (i.e. existing level of trust), collaborative processes, network leadership and management activities, ICT use, and performance. Figure 1 depicts the framework with these key components and potential relationships.

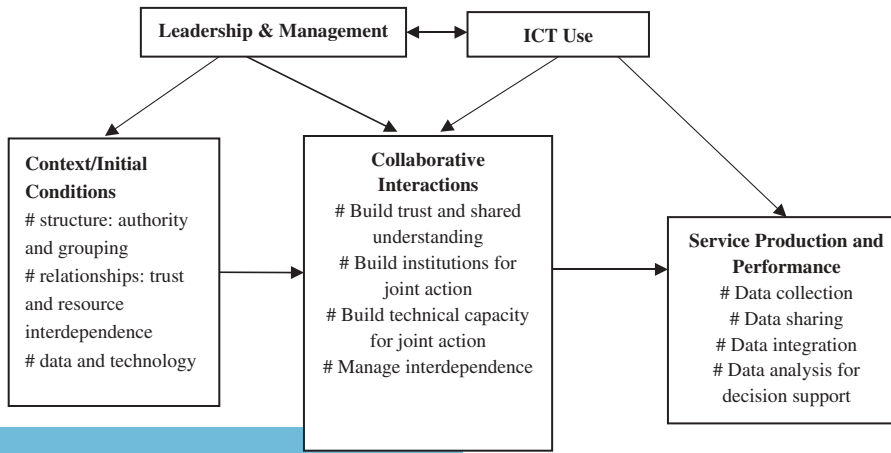

Figure 1. An integrated conceptual framework of managing a collaborative network for information and decision-support services.

Context and initial conditions

The structural characteristics include both authority and grouping (Agranoff 2007). Authority refers to the legal and/or administrative authority of various network-participating organizations to make decisions. Such authority usually has a legal or administrative source. The distribution of authority is a main source of potential power imbalance and conflict. Grouping is about the institutional and organizational design with regard to the governance of the network. Grouping specifies the main governing body of the network, the representation of various network-participating organizations, and the existence and organization of potential subnetworks. A subnetwork could be the group of public employees and organizations for a functional area (i.e. finance, planning) as opposed to a subgroup of elected officials.

Initial conditions are critical for appropriate institutional design, collaborative processes, and management strategies (O'Toole 2015; Emerson, Nabatchi, and Balogh 2012; Ansell and Gash 2008). The initial level of mutual trust resulting from a prior history of collaboration and/or conflict is a critical consideration for the network leadership and management effort. Another important condition to examine is interdependence as captured mainly in the resource flow (Park and Rethemeyer 2014). Such interdependence shapes the degree of motivation for participating in a particular network and the level of commitment at the implementation stage. A higher level of interdependence is likely to foster shared motivation once articulated and perceived by the key network member organizations.

The information and decision-support networks necessitate the consideration of data and technology (Dawes, Cresswell, and Pardo 2009; Yang and Maxwell 2011), although these have not been identified as one of the core components in collaborative governance. Data are the building blocks of information interoperability and analytics for decision support. A network-wide common data collection method and definition can significantly reduce the effort involved in information interoperability. The characteristics of ICT being deployed also make a difference. From the network and collaborative governance perspective, heterogeneity of the technologies used and technical capabilities of implementing them can be an impediment to quality information and decision-support service.

Collaborative processes

Collaborative processes are the interactions and activities that address the specific context and initial conditions of a network collaboration. For trust-building, networks can raise the level of mutual trust by exercising the norm of reciprocity and delivering on their commitments. The information and decision-support networks are likely to follow a similar process to build trust. However, differences could arise in the focus on information-related activities, in which participating organizations reciprocate with each other by sharing information and maintaining the capacity to deliver data to the entire network as a whole in a timely and reliable manner. At the same time, fostering a shared understanding of the goals and nature of the service challenge in a network context is important (Ansell and Gash 2008). Meetings and communications should aid in such a shared understanding.

Building institutions/rules for joint action is another main area of collaborative interactions. For collaborative networks, governance institutions correspond to

authority and grouping. For instance, a governance board has the authority to decide on information standards and data ownership issues. These authority rules, as well as the rules on data standards, are critical for the effectiveness of information and decision-support networks. From an operational perspective, there need to be rules on who needs to share what information and when for conducting joint actions across the entire network.

Building technical capacity for joint action requires addressing heterogeneity in data standards as well as technological capability among various participating organizations and individuals. One way to build such technical capacity is to create a central information system to facilitate information sharing across organizational boundaries. Coupled with appropriate user training for use of the system, the network can build the capacity of individual participating organizations by applying the same technical standards for data collection and quality assurance before sharing with the entire network.

Since networks are designed to implement interdependent tasks, the collaborative process should focus on managing interdependence. Providing tangible financial incentives for individual organizations to share information is a way to manage information–resource interdependence. Only when a network has all the various pieces of information from various contributing organizations, can it provide an enterprise or holistic perspective of the operation and service.

Leadership and management activities and use of ICT

Leadership and management activities entail leading and managing the collaborative processes. Recognizing major gaps in the conditions for success is an important first step in helping a network to achieve its goals. This recognition requires situational awareness to develop an appropriate strategy. If the network's primary issue is a lack of mutual trust among participating organizations, leadership and management should focus on trust-building by fostering shared understanding and employing regular, meaningful communication via face-to-face and other means. If trust is in place and the primary barrier is the lack of a common data standard, effort should be directed to building institutions for joint action in the area of developing common data standards. Addressing the issue of information policy and data standards is particularly prominent in the success of cross-boundary information sharing to create a service-oriented view of information and service (Dawes, Cresswell, and Pardo 2009).

Moreover, a network manager needs to understand the interplay between these processes of trust-building, institutional design, capacity-building, and interdependence management. The network manager may need to simultaneously engage in various management activities such as activating, mobilizing, and synthesizing. One of the most productive tools while engaging in all these activities is the utilization of tangible and intangible incentives. A positive payoff is needed for network participants to overcome the tendency to advance only the narrow interests of the home organization rather than those of the network.

Network leaders and managers can utilize ICT for managing collaborative processes as well as for direct service provision. For collaborative process management, ICT applications such as video conferencing and centralized project management software can facilitate regular communication as well as the demonstration of

reciprocity and commitments. Moreover, a centralized information management system can be part of a network's technical assistance to participating organizations and individuals with limited technical capability to build technical capability for joint action. The use of applications can aid in information service production. For instance, a modelling module in a geographic information system (GIS) can aid in the impact analysis of a regional planning master plan.

Performance of network service production and delivery

For this study, the discussion of performance focuses primarily on the networks providing information and decision-support services. A task-oriented perspective examines the main components and processes needed for the production and delivery of information and decision-support services. The initial task is the data collection by participating organizations. Quality of data collection, use of a network-wide standard, and timeliness of data collection are potential performance measures. The second task is data sharing across the network. Quality can mean whether such sharing has reached its target network audience with the appropriate format in a timely way. The third task is a network administrative organization's compliance with and integration of data from participating organizations and sources into a standardized view of data. Quality is measured by the level of standardization and whether data are relevant to making decisions. The last task involves the analysis of data and the communication of results to support the decision-making process. Both the timeliness of such analysis and the effectiveness of communication as perceived by users can be relevant performance measures.

Research design, methods, and data

This study employs an exploratory case study method to answer the research questions. This method helps address a current research gap in understanding the process aspects of information and decision-support network management and the interplay between context, collaborative processes, management, and performance. Although case study does not offer confirmative statistical correlation in a large *N* study, it provides opportunities to improve conceptual validity, generate new hypotheses, and explore causal mechanisms and complex interactions (George and Bennett 2005; Yin 2003).

The case selected is a governance network run by a MPO that spans two Midwestern states. The focus of the study is on the network activity associated with transportation planning, which requires the MPO to compile, integrate, and analyse transportation data to provide information services to participating governments and to support their transportation-related decisions. The MPO, however, does not have authority over participating governments in terms of data collection. As a result, metropolitan transportation data collection and compilation are commonly done in a collaborative manner in a network of governments and organizations.

The primary data collection included document reviews and interviews. In March and April 2015, our research team had meetings with key staff members in the MPO to introduce this research project and ask for their support. The MPO allowed us to access internal documents (e.g. Memorandum of Agreement for Transportation Planning and Programming) and introduced potential interviewees. This study reviewed key internal

and publicly available documents on the structure and activities of the MPO and transportation planning. This study also conducted interviews with seven key stakeholders, including three participating governments (two from a county government and one from a city government) that provide data to the MPO, and four staff members in the MPO (a programme director, two planners, and a GIS coordinator). Interview questions were designed to capture key variables in our research framework (see selected interview questions in Appendix A). These interview transcripts provide information on the workflow, specific data collected, technology, staffing, incentives, collaborative activities and interactions, and areas for improvement.

Data analysis followed the guidelines and processes of case data analysis as suggested by Yin (2003) as well as Miles, Michael Huberman, and Saldana (2014). Based on the documents and interviews, we established the history and context of the case. The case analysis follows the main components identified in the proposed framework (see Figure 1) while allowing for the emergence of nuances and patterns. We have also examined the processes of production and delivery of information and decision-support service by establishing the workflow for data gathering and analysis as well as communication of the results. Additionally, we have identified key factors for success by identifying the themes of the interview data.

Case description and analysis

Organizational context

The specific case of collaborative data governance is the Metropolitan Area Planning Agency (MAPA). MAPA was established in the 1970s as the chief planning agency for the Omaha-Council Bluffs metropolitan area spanning metropolitan territory in Nebraska and Iowa with a combined population of approximately 865,000 according to the US 2010 Census. The main governance body of MAPA is a 63-member council of officials, representing each of the 63 governmental units that comprise MAPA. Most decisions are made by the Policy Board of Directors (PBD), which is comprised members from local governments in both the State of Nebraska and the State of Iowa.[1] The main areas of responsibilities for MAPA include transportation data and planning as well as community and economic development. The biggest area of responsibilities is transportation data for regional planning.

MAPA is the designated agency in the Omaha-Council Bluffs metropolitan area for transportation data that are locally collected by participating governments in the metropolitan area, including the City of Omaha, Douglas County, and Sarpy County in Nebraska and the City of Council Bluffs and Pottawattamie County in the state of Iowa. MAPA is responsible for obtaining data from these government bodies to create a metropolitan transportation plan and for producing a comprehensive transportation improvement plan every 4 years.

Context and initial conditions

Based on the analysis of the documents and interview data, we provided a summary of findings in Table 1. This table includes data and relevant facts as well as the narrative on features of various components context and initial conditions.

Table 1. Conditions and context of the collaborative transportation data governance.

	Relevant rules/facts and characteristics
Structure: Network authority	• Overall enabling authority: Federal government mandate to enable MPO to be the lead organization for metropolitan area transportation planning; MAPA's Policy Board of Directors is the highest level decision body inside MAPA overseeing all decisions • Technical authority: TTAC advises the MAPA Policy Board of Directors about 'the Transportation Improvement Program, ongoing plans and studies, and provides valuable stakeholder feedback into the transportation planning process'
Structure: Network grouping	• Jurisdictional for traffic data provision: Anchor city in the metropolitan area, two counties in Nebraska, Iowa Department of Transportation covering Council Bluffs, Pottawattamie County, and other neighbouring small cities • Functional grouping: The information and technical group across organizational boundaries (information technology department, GIS people), operational group that includes traffic engineer and public work people, and policy group including heads of local governments and planning departments
Relationship: trust and resource interdependence	• Personal connections are the key rather than institutional ones • Level of trust depends on the grouping and individuals • MAPA depends on various local governments in the network to collect and share information • Financial incentives in the form of fund pass-through to pay for staff time and technology are the resource that MAPA can provide
Data and technology	• Traffic data collection (tube vs. manual counting with a device): difference is mainly between anchor city and the rest • Traffic data integration and analysis: much more under the control of MAPA but the biggest challenge is converting various data sources into geo-coded uniform data • Technology for data integration and analysis: Excel, GIS, mapping applications • Communication technology: communication among network member organizations: primary e-mail and file attachments, to external constituents and the public: website, Facebook, and Twitter

TTAC: Transportation Technical Advisory Committee; MAPA: Metropolitan Area Planning Agency.

Authority and grouping

The overall authority of MAPA originates from the Federal Government's mandate designating it the organization for metropolitan area-planning purposes. MAPA has authority over participating local and state governments to act as the coordinating agency to compile transportation data, conduct analysis, and prepare reports for the Federal Department of Transportation for its metropolitan area (MAPA 2014).

However, it does not have explicit authority to collect data on the ground. Nor does it have the authority to dictate transportation data collection methods.

Inside MAPA, the PBD is the top-level decision-making body that oversees all decisions made by MAPA, including transportation issues. The highest technical authority for transportation data and planning is the Transportation Technical Advisory Committee (TTAC). Both the PBD and TTAC have authority over the program office of MAPA with regard to transportation planning.

Two types of network grouping emerged from the analysis of documents and interview data. The first grouping is by jurisdiction. For the metropolitan area, the City of Omaha (hereafter, anchor city) is the largest city in the area that provides transportation information. Douglas and Sarpy Counties also provide transportation data covering other cities in the metropolitan area. For Council Bluffs in Iowa, as well as Pottawattamie County and other small cities in the same Metropolitan area, transportation data have been made available via the Iowa Department of Transportation website, with data collected locally. The vast majority of transportation data are from the anchor city as well as the Iowa Department of Transportation. The second grouping is by functions. The interview data reveal frequent correspondence and collaboration among IT and planning staff, particularly in the GIS area. Functional area employees who are directly responsible for traffic data, such as people in the engineering and public works departments, form another distinct group.

The primary grouping generally follows jurisdictional lines while operating in the network and inside their home organizations. For instance, interviewees reported that traffic engineers in the anchor city see their home city as their primary obligation and traffic data collection as their primary responsibility. The needs of the network and other jurisdictions seem to be secondary. The staff in the IT department have no jurisdiction over the traffic employees in a separate department. From the perspective of data collection and sharing, such a jurisdictional divide based on functional areas inside a government is even more pronounced than the divide across governments.

Relationships: trust and resource interdependence

The trust relationship across organizational boundaries is primarily based on personal ties and secondarily on institutional trust. The interview data show that the highest level of trust is evident among people who belong to the IT and GIS community. The trust level is relatively lower between the technical group and the functional groups with regard to data quality. A trust relationship that is based on personal ties also suggests that individuals matter. The individual who has been the main GIS coordinator at MAPA seems to have the trust of the information providers gauged by their willingness to work with the MAPA person on various initiatives. In contrast, a new staff member at MAPA faces the challenge of gaining the help and support of information providers in other jurisdictions.

MAPA depends on the participating governments for the collection and sharing of transportation information. MAPA needs traffic data on a regular basis from participating governments to develop a transportation improvement plan. Such information resource dependence ties MAPA and other participating government agencies together. Another side of resource interdependence is MAPA's provision of resources to local governments. MAPA obtains federal funding and passes on some of these funds to major local government agencies on the order of $20,000–40,000 specifically for transportation data collection in the form of paying for staff time and technology.

More broadly, MAPA provides resources in other areas such as community development to the same cooperating agencies. Such provision of resources has been recognized by the participating local government agencies as a major activity in trust-building.

Data and technology

Participating governments have a variety of data collection methods that create challenges for data integration. In the anchor city, traffic data are collected via manual input using hand-held devices. In other counties, the primary method is the use of tubes laid on the road to count the number of vehicles passing through. This difference in data collection methods requires calibration on the part of MAPA to harmonize the data and make sense of traffic counts.

The variety of data collection methods and lack of geo-coding require MAPA to make intensive efforts to integrate data from various sources. With the approval of the TTAC, MAPA has direct control over the method and technology for data integration and analysis. Its main task is to convert heterogeneous data formats into a standardized geo-coded one in a GIS database.

The technologies used for traffic data processing at the local governments vary significantly. The anchor city uses hand-held devices to enter traffic data and uploads them to a local computer. A specialized software, coupled with Excel, is used for traffic data processing. The counties use devices connected to traffic-counting tubes to gather the traffic data and upload them to the computers in their information system departments for data processing. At MAPA, the main software used to do initial processing is Excel, with the geographic information then added to be loaded into the ArcGIS software. The use of TransCAD coupled with ArcGIS helps produce the traffic-flow analysis.

Stages of information service production and managing collaborative governance activities

Workflow and the role of various groups

The first stage of producing transportation information service is traffic data collection and collaboration inside a local government. The functional department (i.e. Public Works) plays the dominant role in collecting traffic data at the first stage in that it makes decisions on the method and the timing and frequency of data collection. The interview data suggest, however, that the IT departments in various local governments typically play an assisting role. For the anchor city government, there is minimal involvement of the IT department in traffic data processing. In contrast, for county governments in the metropolitan area, the IT departments process the collected traffic data.

The second stage of traffic information production is data sharing across organizational boundaries. The main group is the data and technology staff in both MAPA and the participating local government. The IT department is the main point of contact for cross-boundary data sharing with the exception of the anchor city. MAPA makes the information requests and follows up with reminders. It can take between 2 and 6 months for MAPA to obtain traffic data from individual local governments.

The third stage is data integration that harmonizes traffic data collected through different methods and definitions. MAPA does all the work while consulting with the

Table 2. Collaborative network governance dynamics and management activities.

	Governance dynamics and management activities
Build trust and shared understanding	• Provide steady funding and assistance • Cultivate personal relationships via committed and principled interactions (repeated and timely communication) • Create shared understanding via communication mostly among the data people
Build institutions for joint action	• Have an agreement between the MPO and the state agencies • Some discussion among GIS folks and MAPA internal staff about common data standards
Build technical capacity for joint action	• Adopt GIS • Discuss a single portal and direct-data upload
Manage interdependence	• Secure grants and perform pass-through to provide incentives for participation • Strengthen ties by adding values beyond transportation data

TTAC on technical standards and with participating local governments on the technical details. The group leading this stage is the staff in MAPA's program office that is responsible for data integration. The last stage is data analysis and generation of maps/reports. The program office of MAPA is mainly responsible for preparation of presentation and reports.

Collaborative governance activities and their management

The first area of collaborative governance activities is building trust and shared understanding as shown in Table 2. Currently, the primary way for MAPA to win the trust and support of participating local governments is to provide financial support for activities related to regional planning and transportation. The main units of local governments benefitting from these funds include the public works departments, planning departments, and GIS units. Moreover, there are regular and ad hoc meetings between participating governments and MAPA to cultivate trust and create a shared understanding. There is frequent communication among GIS and data people on technology needs beyond the traffic count. The interviews with MAPA staff suggest the importance of personal relationships in securing cooperation from the relevant departments in these local governments to provide transportation data.

The second area is institution-building for joint actions. The main existing agreement for transportation planning is between MAPA and state agencies (MAPA 2014). The authority of direct data collection by MAPA, however, is rather limited. An explicit institutional agreement is lacking between MAPA and various local governments in terms of setting data standards. As an effort to build institutions for joint action, some GIS and data personnel in MAPA and other local governments have initiated a conversation about traffic data standards.

The third area is to build technical capability for joint actions. Currently, such activities focus on building GIS capabilities in terms of software and use. Most of the equipment money for MAPA and assistance to other local governments is applied to

the GIS software license to acquire capabilities for better data quality and information interoperability with geo-coded data.

Lastly, MAPA plays a leadership role in managing resource interdependence. Although the most important task for MAPA is to manage interdependence while collecting and sharing transportation data, MAPA faces challenges when the anchor city and other participating local governments utilize their own traffic information for their planning purposes and thus are less dependent on MAPA. But MAPA provides values beyond transportation data when working with both public works and IT/IS units to strengthen resource interdependence. The interviews reveal that these department and local government units see MAPA providing coordinating service beyond transportation data and acting as a gateway to secure and manage federal grants that would otherwise be unavailable to these departments and units.

Driving the performance of the collaborative transportation data networks

The performance of this information and decision-support network administered by MAPA can be measured by the efficiency and effectiveness in various components of producing and providing relevant service. With regard to traffic data collection, data collection by individual jurisdictions has proven cost-effective as they have deployed the least-cost approach to data collection with use of either a traffic-counting tube or a hand-held counting device to collect traffic information. From the network-wide perspective, however, the variety of data collection methods used creates issue later on for data integration.

In terms of data integration, MAPA has only been able to generate high-quality data by investing significant time and resources. A considerable amount of time has been required for MAPA to model traffic flows of major roadways when the traffic count of one section of road is collected by one jurisdiction using one method and the other section of the road is collected using a different method. For data analysis and communication, the performance level is relatively high. Such performance is evident in the deployment of GIS and traffic-flow modules, as well as in MAPA's ability to integrate traffic-flow information from all directions of the interaction for the entire metropolitan area – as well as the traffic flow of highways cutting through the metropolitan area.

One of the challenges associated with improving network performance is the lack of collaboration between IT and functional units at the same local government. The IS/GIS interviewees – who understand the need for data standardization for improving data sharing, integration, and analysis – indicate their limited influence over the functional department people in the effort to standardize traffic data collection.

Incentives alone are not sufficient to improve the consistency and quality of data at the point of data collection in a network with distributed authority. The resource pass-through is sufficient to cover the cost of the majority of data collection activities in a particular department of the local government. However, as the limited success in establishing a uniform data collection suggests, such pass-through itself is not sufficient for the development and implementation of common data standards.

There has been strong cohesiveness and support from the GIS members of the collaborative data network. GIS interviewees have indicated their support for implementing guidance from MAPA with regard to data collection and standardization. These interviewees have also commented that the resource support from MAPA for

their GIS operation is helpful. Moreover, interaction and communication reaches beyond just the traffic data. It covers regional planning that affords these GIS members of the network with regular contact and communication in regional planning activities, data forums, and a new aerial-mapping initiative.

Tracing the key events in the documents suggests that having the right talents who understand and properly utilize technology can significantly improve efficiency and effectiveness of information service. That is, one of the most significant contributions comes from the role of the GIS specialist at MAPA. Shortly after joining MAPA, the GIS coordinator migrated the traffic count data from an ACCESS relational database to a GIS (geo-coded) database to improve efficiency and effectiveness of data storage and analysis.

This case study suggests that technology can improve performance. For data integration and analysis, the enactment of appropriate technology by a key network staff member can significantly improve the efficiency and effectiveness. In addition, the potential of technical capabilities provides the needed vision and strategic goals for the network to further improve information service. For example, a cloud-based GIS portal, combined with appropriate technologies at the point of data collection, can significantly improve the workflow and process of data collection, analysis, and information dissemination. A hand-held device with wireless data services and accurate geo-coded traffic count could provide high-quality real-time traffic information to the portal.

Discussion and implications

The finding of a relatively significant jurisdictional divide between functional areas underscores the need to address the different priorities and interests between programme and IT people as articulated in the earlier literature (Kraemer et al.1989). Such a divide between functional areas is probably more salient in contexts where there is a lack of common standards for network member organizations in data collection and processing. The findings from this case study suggest a different emphasis when common standards are lacking and the network administrative organization does not have the standard-setting authority – which also underscores the importance of fitting strategy to a particular network structure rather than applying the same strategy to all structures (O'Toole 2015; Provan and Kenis 2008).

In terms of practice, the concern about divide between functional departments for improving cross-boundary data collection and data sharing would imply a different management strategy. The formulation of common standards may need to involve the heads of the functional departments that are directly responsible for data collection as well as the top executives of the examined governments. This recommendation provides the specifics of network management activities, especially the network member activation suggested by McGuire (2002). Moreover, for the building of institutions for joint action (Emerson, Nabatchi, and Balogh 2012), the findings suggest more attention should be given to the groups that align more with their functional responsibilities across the network rather than those departments within the same organization.

Second, the limited success employing only incentives to improve the standardization of data collection methods is probably more pronounced in an existing governance structure that does not provide MPOs the authority to mandate data-collection

methods. The findings highlight the need to tie incentives to guidance/requirements for the purpose of improving data quality and information interoperability. The need for such coupling between incentives and requirements advances our knowledge about network management in terms of the need for coupling incentives with rules rather than offering financial or technical support alone. This need also suggests that some level of guidance and mandate is required.

Third, the success of building a subnetwork of GIS professionals underscores the importance of core areas of collaborative management activities, including regular communication to build trust, direct and ample incentives to win commitment to the network, and capacity-building for joint action. For practice, this study points to the need for information and decision-support networks to simultaneously pursue multiple areas of collaborative management activities to get results.

Fourth, the finding that a key network manager with expert knowledge on relevant technology contributes to service performance improvement underscores the performance impact of combining human capital and appropriate technology to advance information service. The relevance of knowledge about technology is probably more applicable for the class of information and decision-support service networks. The salient role that technology and technical knowledge play in these types of networks suggests that knowledge about and deployment of appropriate technology can significantly improve the quality of service (Yang and Maxwell 2011).

For the role of technology, this case study demonstrates that the appropriate use of relevant technology can significantly improve performance in data quality, data integration, data analysis, and visualization. Such a finding implies the need for elevating the importance of data and technology in driving performance. Moreover, discussion about the value of technology can inspire a network to set goals for the next level of performance. The motivating and goal-development aspects of technology for collaborative governance networks add nuances to our knowledge. Network managers can raise the importance of discussing technology and its potential as a way to discuss shared performance goals for the network. These management recommendations based on the case contribute to our understanding of the specifics of managing collaborative networks as related to technology. This study contributes to the existing network studies by directly addressing the role of IT in performance. For e-government studies, this finding provides insights into the interplay between technology and management when discussion about the performance-improvement potential of technology can be used as a network management strategy.

Conclusion and opportunity for future research

This article provides an integrated framework for managing the performance of information and decision-support networks. This framework integrates bodies of literature to enhance our understanding of the interplay among context, management, technology, and performance in a network setting. The proposed framework is one of the first efforts to integrate insights from several bodies of literature to advance the theory and practice of managing digital government in a cross-boundary setting. Moreover, this article conducts an exploratory case study, guided by the framework while allowing for the development of grounded theory, to explore the mechanisms by which the performance of an information and decision-support network can be improved.

The findings of this exploratory study offer several points for the advancement of theory and practice. First, managers and researchers need to pay attention to the divide between functional department staff and IS/IT staff both inside a jurisdiction and across the network. This case shows that, especially in the context of a lack of authority and common technical standards, this division can be one of the major barriers to major improvement in data integration and service quality. Second, there is a need to combine incentives with guidance and standards to drive results. The limited success in driving performance by the provision of incentives without strong guidance and standards suggests such a need. Collaborative network management needs to build institutional capacity for joint action (common standards and monitoring). Third, the combination of various collaborative network management strategies is effective, at least as evident in the GIS subnetwork. Such a finding suggests the need to combine communication, incentives, and technology for building a collaborative network.

Fourth, this case study suggests the performance-improvement potential of a network manager who understands and utilizes appropriate technology. For data-intensive information-service networks, having a tech-savvy network manager can be an asset to leverage technology for service improvement. Lastly, this study also points to the way in which technology can make a difference in service improvement. Conversation about the potential of technology can serve as a way to create shared goals and motivate network participants.

The utilization of the case study approach, while possessing the strength of generating new insights into collaborative data governance, does have its limitations. The findings of this study, although instructive in showing some potential pathways for network success or causal mechanisms, should not be treated as confirmative theory testing. Future research needs to examine other similar networks of information and decision-support service at various stages of development. Moreover, the statements made are specific to information and decision-support networks in which IT plays an important role in service production and delivery. Any generalization beyond this type of network should proceed with further empirical investigation of other types of networks.

Note

1. For the complete list of governmental units in the Council of Officials, visit http://www.mapacog.org/boards-a-committees.

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Appendix A. Interview questions

- When did you first become involved in reporting/using traffic counts?
- What is your relationship or experience with MAPA?
- Could you please describe your organization's process for reporting traffic information to MAPA? (Who is involved, how you go from getting the initial request from MAPA to sending them the information)
- How does your organization collect traffic count information?
- How do you store the data on traffic counts?
- Do you get the traffic count information from MAPA? If so, when and for what use?
- Do you think MAPA's unified traffic information useful for your organization? If so, in what way?
- Could you please describe your difficulties/challenges in working with MAPA on reporting traffic counts?
  - o Your suggestions for improvement?
- How would you describe the role of your organization in the effort of the long-term traffic pattern programme?
- Which rules and/or regulations that you need to follow for the purpose of collecting traffic data?
- Do you receive any assistance from MAPA or other organization for the purpose of collecting traffic data?
- Besides MAPA, which organization do you work with to collect traffic data?
- Do you have any suggestions on the kind of technology, software programme, and/or website that would be useful for the purpose of traffic data?
- What do you think about a portal hosted by MAPA for you to use for submitting, storing, and retrieving traffic count data?
- What is the first idea that comes to your mind when you think about the traffic count project?
- What are the main goals and objectives of traffic count project in?
  - o How have the goals evolved?
- Can you describe briefly the history of the traffic count project in your organization?
  - o In what ways were important stakeholders involved?
  - o What are some of the major milestones?
  - o Any documents (e.g. annual report) you can share with us?
- How has the traffic count project changed the delivery of public services in your organization?
  - o In what ways has the traffic count project changed the nature of work for your employees? How were employees involved in developing the traffic count project?
  - o In what way, are have citizens benefited from your organization's implementation of the traffic count project? How were citizens involved in developing the traffic count project?
- What factors have enabled a smooth implementation of the traffic count project?
- What factors have impaired the smooth implementation of the traffic count project?
- In general, how is the technology side of the traffic count project managed?
- How do you evaluate the performance of the traffic count project in your organization?
- What is the relationship with federal, state, and other local governments in terms of implementing the traffic count project?
- With regard to the traffic count project, please tell us the agencies that have provided your agency with the traffic count data?
- With regard to the traffic count project, please tell us the agencies that your agency has provided the traffic count data?
- With regard to the traffic count project, please tell us the agencies that your agency has sought advice from?