STRUCTURAL DEVELOPMENT OF PUBLIC MANAGEMENT NETWORKS
OVER TIME:
WHERE PROCESS MEETS STRUCTURE

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When I was three years old, my parents asked me a typical question: “What are going to be when you grow up?” Without any hesitation, I answered that I would like to be a professor. My parents were puzzled and thought that I didn’t know what I was talking about. My childhood dream came true, but not without the help of many wonderful people without whom I never could have finished this journey to an academic career.

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the Soviet era, she infected me with a passion for reading books and understanding the
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Aleksei Kolpakov

Structural Development of Public Management Networks Over Time: Where Process Meets Structure

The main goal of the dissertation is to develop and test the conceptual framework for the structural development of public management networks over time. The present research has three foci: it offers a framework of structural tendencies of public management network organizations using a multi-theoretical multilevel approach (Contractor, Wasserman, & Faust, 2006) in the dynamic perspective, it suggests propositions about structural configurations of public management networks in the different stages of network development and it tests suggested propositions regarding structural tendencies of public management networks over time. Therefore, the present research is intended to answer the following questions that are both practically and theoretically important - at the theoretical level, it moves away from traditionally adopted public administration approaches to describe and explore network processes at one level and using one theory to actually confirm and make inferences using multiple theories and different levels of the networks. Using the case of Metro High School in Columbus, Ohio, I will test a theoretical framework of the structural development of public management networks over time using different theories at the different levels of networks:

1. What processes are predominant for each stage in the evolution of public management networks?
2. What are the structural configurations of public management networks in the different stages of network development at levels of the network (actor level, dyadic level, triadic level and global level)?

3. What is the effect of individual characteristics of the network actors such as gender, sector differences and inter-organizational network experience of on the structural configurations of public management networks over time?

The present dissertation aims to develop a theoretical framework clearly explaining structural development of public management networks over time using sociological, organizational and public management theories at the different levels of network (actor level, dyadic level, triadic level and global level). Contractor, Wasserman and Faust (2006) offer “a more theoretically and a methodologically sophisticated approach to explain the emergence of network.” (pp. 700-701). I use their study as a methodological guide to develop a theory of structural development of public management networks over time.

The present research has potential theoretical and practical contributions to the field of public management. From a theoretical perspective, the proposed research can contribute to theory building in the field of public management by developing testable structural hypotheses that can explain the development of public management networks. By now, public management network research had been flooded with one or two network case studies using descriptive network analyses and calls for predictive models linking structural and process antecedents of the network performance (Isett & Provan, 2005; Lemaire & Provan, 2009; Provan, 1993; Provan, Beyer, & Krutybosch, 1980; Provan & Huang, 2012; Provan, Huang, & Milward, 2009; Provan, Lamb, & Doyle, 2004; Provan
The present research has also a potential value for policy makers, public managers and public program evaluators who evaluate the efficiency and effectiveness of networks as the responses to the complex and “wicked problems” (Rittel & Webber, 1973). The conceptual and methodological framework on structural configurations of public management networks in the various stages of development can be used by policy analysts and public program evaluators to understand, measure, and, evaluate the main aspects of network effectiveness using statistically robust approaches in network modeling.
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CHAPTER 1: RESEARCH MOTIVATION

This dissertation investigates the structural patterns within the developmental processes of collaborative networks comprising both governmental and nongovernmental organizations. The research pays special attention to how collaborative networks develop over time in terms of structural configurations at different stages of network development. It uses a multitheoretical, multilevel framework to explain the structural development of public management networks, using sociological, organizational and public management theories at the different levels of a network (actor, dyadic, triadic and global levels). The methodological approach taken here transcends the conventional approach adopted by public administration researchers who normally provide only descriptive analyses of networks at one level and at one point in time.

1.1 Why should we care about structural aspects of network evolution?

The problem addressed in this research arises because of a lack of basic knowledge about structural development in networks. As a policy tool, networks attracted the attention of public policy and public administration scholars as well as public sector practitioners for the last three decades. This can be explained by the changing interactive and multiorganizational nature of policy making and policy implementation. Both public policy and public administration scholars have argued that processes of policy making and policy implementation have become more complex and “messy” due to the fact that policies now address more “wicked problems” (Rittel & Webber, 1973) in complex
environments (Koppenjan & Klijn, 2004; Mason & Mitroff, 1981; Radford, 1977; van Bueren, Klijn, & Koppenjan, 2003). These intractable problems have to be analyzed and solved in an environment characterized by a great degree of uncertainty, volatility and complexity. These problems are also hard to analyze since they do not have clear cause-and-effect structures, which can be numerous and interrelated (van Bueren et al., 2003). In addition, government is no longer able to address these wicked policy problems using traditional hierarchical bureaucratic structures, for these structures are unable to handle ever-changing and complex environments (Lipnack & Stamps, 1994). Under these conditions, “government, while charged with addressing important public problems, seems unable to deal satisfactorily with the issues on its agenda” (Hanf & O'Toole, 1992, p. 3). Government, no longer trusted to be the sole provider of public goods and services, has become very heavily dependent on private and nonprofit organizations to provide external goods and services (Salamon, 1981; Salamon & Elliott, 2002). In this complex and uncertain environment, characterized by the low legitimacy of the major policy-implementation player (O'Toole, 1997a, 1997b, 1997c), networks are recommended as the best tool to address these wicked policy problems. According to Agranoff (2003, p. 6), these networks “bring the nonprofit and for-profit sectors together with government in a number of policy arenas, including economic development, health care, criminal justice, human services, information systems, rural development, environmental protection, biotechnology, transportation, and education” (2003, p. 6).

Despite the challenges, some progress has been made in understanding the process of the development of public management networks. Nevertheless, we still need to understand the structural aspects of network development in interorganizational
collaboration across different sectors. At present, there is almost no agreement among policy analysts and public administration scholars.

The current research on public policy and public management networks focuses intently on studying networks at one point in time. Most of the research studies in public policy and public management suffer from a static perspective, ignoring how networks are developed over time. A few researchers (Graddy & Chen, 2006; Gulati & Gargiulo, 1999; Human & Provan, 1997; Isett & Provan, 2005; Kenis & Knoke, 2002; Ring & van de Ven, 1994), however, have proposed theoretical models for network development or have empirically tested network development at different stages. Graddy & Chen (2006), for example, empirically studied service delivery networks in the Family Preservation Program in Los Angeles County in order to explain the contextual pattern of network formation. Another group of researchers related network outcomes to the characteristics of the network and its actors at the stage of network formation (Alter & Hage, 1993; Mandell & Steelman, 2003; Meyers, 1993). No known studies, however, have paid attention to structural configuration across the different stages of development.

The process of initiating, organizing, mobilizing and terminating networks is resource- and time-consuming. But by focusing primarily on cross-sectional research and by studying only particular aspects of networks at one period in time, current public-network research fails to capture these dynamic network-development processes. This leaves public-policy and public-management scholars with only a vague idea about the processes of formation, development and management within public management networks and with very little to offer public administration practitioners who want to more effectively manage their own networks. The underdeveloped state of dynamic
theories about public networks also limits the efforts of policy analysts and public program evaluators to assess the effectiveness and efficiency of public management networks vis-à-vis other approaches to collaboration. If public administration scholars can develop a streamlined theory of network development, the world of public administration and policy practitioners will benefit by having clearer guidelines for adding public value through developing and managing public policy and public management networks.

Different streams of research in public policy and public management have attempted to shed light on the processes of formation and development of networks from a network-management perspective. Rethemeyer & Hatmaker (2008) identified four perspectives of network management in the research by policy and public administration scholars. The first perspective derives from the research of policy scholars who focus their attention on network formation in terms of what Börzel (1998) identified as “interest intermediation” (p. 254). Network process is understood here as the process of achieving consensus on goals or policy options, so this concept has limited application when developing, managing, and implementing networks, especially action networks, that directly impact policy or programs (Agranoff, 2007). The second perspective stems from the work of scholars who focus on the instrumental side of network processes, specifically implementation and collaboration processes (Bruijin & Heuvelhof, 1997; Goldsmith & Eggers, 2004; Kettl, 2002; Salamon, 2002). The third perspective represents the work of scientists focused on the information processing and knowledge management aspects of public management networks (Dyer & Nobeoka, 2000; Kogut, 2000; Koppenjan & Klijn, 2004; Powell, 1990; Powell, Koput, & Smith-Doerr, 1996). This
research is limited to studying the exchange of tacit and implicit knowledge for coordinating joint activities in what Agranoff (2007) calls informational, outreach, developmental and action networks. The fourth perspective, called governance, comes from scholars who challenge the politics-administration dichotomy and do not separate decision and implementation processes in the network (Peters, 2002; Rethemeyer, 2007). Rethemeyer & Hatmaker (2008, p. 631) argue that “political contention over goals and processes continues through the life of an agency, program, initiative, or policy; and that the set of players cannot be easily divided into ‘interest groups,’ ‘agencies,’ ‘service providers,’ etc.” (p. 631). Each of these streams of research in public policy and public administration directly or indirectly attempt to partially explain the process of network development but do not provide a comprehensive model that explains the process of the network in detail (Rethemeyer & Hatmaker, 2008).

Research conducted on the role of managers in the process of network formation, development, and management has resulted in two process models based on a network-management perspective. The first model is based on two types of managerial actions in the network and reflects the dual nature of networks: how managers alter “action in network” and how managers alter “networks of action” (Rethemeyer & Hatmaker, 2008). Klijin & Teisman (1997) developed a very intriguing conceptual model that explains the different processes in network formation, development, and management. They conceptually distinguish between game management and network-constitution management. The purpose of game management is to influence and facilitate interaction processes in games that are played regarding particular issues, whereas network constitution is aimed at changing the organizational and social context of the game. Both
types of network management impact perceptions, actors and institutions. Game
management facilitates perceptual congruence among actors in terms of what needs to be
done, what resources should be used, and what opportunities should be explored. It
mobilizes or demobilizes actors who possess the necessary resources for the network. It
also arranges actors who are playing necessary games in a way that ensures low
transaction costs for most of the actors. Network constitution changes networks by
changing actors’ perceptions with regard to what games to play in the future or what
really matters, by bringing in new actors or reallocating positions among the present
actors, and finally by changing the rules and resources in the network (Klijin & Teisman,
1997). This model suggests that effective network managers should balance these two
types of network management and use them in a complimentary way. Rethemeyer &
Hatmaker (2008) challenge this network management model and argue for the
inseparability of policy and administration, claiming that network managers should be
engaged in both policy and implementation networks, which are constantly interacting in
an iterative manner.

Another model of network processes that emphasizes the role of managers was
developed by Agranoff & McGuire (2001b). In their seminal work, which neatly
summarized network literature at that time, they proposed four network-management
processes that potentially constitute a POSDCORB equivalent for the age of networks:
activation/deactivation of the network actors, framing the content of network activities
and the context of the games, synthesizing, and mobilizing. Activating is focused on
identification of the right participants and stakeholders with the right resources—such as
money, information, and expertise—who can serve as integrating mechanisms in the
network. Deactivation occurs in a situation where network structures fail to achieve the desired level of performance and need to be rearranged and restructured in order to get better results. Framing includes the establishment and enforcement of rules, which influences network values and norms and changes the perceptions of network actors. Other framing tools include the introduction of new ideas, the development of a shared vision, new perspectives when looking at a problem, and recommendations of an alternative mechanism for decision making. Mobilizing requires network managers to continuously build and ensure support for the network from participating organizations and their stakeholders throughout the entirety of the network’s existence. Mobilizing implies not only external support for the network but also internal support from and cooperation of the manager's base organization. Synthesizing is aimed at the establishment and maintenance of a proper environment that will ensure fruitful and healthy relationships among the various participants, who each have different goals, perceptions and values. Various management behaviors can be employed by network managers such as

- facilitating and furthering interaction among participants (Agranoff and McGuire 1999a; Kickert and Koppenjan 1997);
- reducing complexity and uncertainty by promoting information exchange (Innes and Booher 1999; O’Toole 1988 and 1997b; Mossberger and Hale 1999);
- changing incentives to cooperation (Kickert et al. 1997);
- developing new rules and procedures of interaction (Klijn 1996; Termeer and Koppenjam 1997);
- changing positions, relations, and roles of participants (Klijn 1996; Kickert et al. 1997);
- helping the network to be self-organizing (Innes and Booher 1999); and
- engendering effective communication.

Although these two process models can be very useful to managers as guidelines for managing public management networks, they do not directly address network management from a time perspective. In other words, these models do not address the development of networks stage by stage.

Some researchers investigating the development of strategic alliances in the private sector have also attempted to model the dynamic processes involved in network development. These proposed models show that the different evolutionary paths taken by the strategic alliances can have an effect on their effectiveness and performance (Doz, 1996; Hamel, 1991; Larson, 1992; Ring & van de Ven, 1994). Doz (1996) developed a model of alliance evolution that links the initial conditions to the outcomes of the strategic alliances and emphasizes different learning processes in the network. Initial conditions such as task definition, partners’ organizational routines, interface structures and partners’ expectations were found to facilitate or inhibit learning about things such as the environment within which the alliance was operating, how to accomplish tasks collaboratively, about the process of collaboration, and about their own and their partners’ skills and goals. According to Doz (1996), the evolution of strategic alliances goes through a sequence of learning-reevaluation-readjustment cycles, which can have a positive and cumulative impact on commitment to the relationship. A special emphasis is paid to early “small” events in an alliance that can “have a disproportionate importance in establishing, or not, a self-reinforcing cycle of heightened efficiency expectations, greater institutional and personal trust and commitment, joint sense-making and learning, and
greater flexibility and adaptability” (Doz, 1996, p. 77). Therefore, public managers intending to engage in the building and management of interorganizational networks should pay special attention to these early events that are conducive to building trust and collaboration.

Ring and van de Ven (1994) succeeded in developing a more or less explicit model of the evolution of interorganizational networks. According to this model, interorganizational networks are developed through an iterative cycle of negotiations, commitment and execution. Each stage consists of a series of interactions, the outcomes of which are assessed in terms of efficiency and equity. During the negotiation stage, network actors develop joint expectations and deal with the perceived uncertainties of the agreement by engaging in formal bargaining processes and informal sense-making mechanisms. In the commitment stage, parties are engaged in a series of interactions to develop by consensus the commitments and rules for future actions that will be later solidified into either a formal relational contract or an informal psychological understanding among the parties. During this stage, organizational representatives do not go beyond the behaviors prescribed by their defined roles and rely primarily on interrole relationships. The execution stage is characterized by the implementation of the commitments and duties developed in the previous stages. Rules for future action are especially helpful at this stage since they reduce uncertainties while commitments are being executed. As a result of contract interactions, parties begin relying more on the interpersonal relationship rather than on interrole relationships. This model calls for balancing the formal and informal processes, which can be contradictory in practice.
Understanding the process of development or evolution of public management networks is the key for prescribing effective network management mechanisms and requires studying dynamic network processes. However, public management and public policy scholars have paid little systematic attention to the dynamic processes of network development, especially from the structural perspective.

Existing studies on the structural configurations of public management networks traditionally focus on the implementation stage of network development using the case-study method approach (Huang & Provan, 2007; Provan & Milward, 1995). In their seminal 1995 comparative study of four community mental health systems, Provan and Milward (1995) proposed structural postulates of network effectiveness in the execution or implementation stage. According to the results of the study, a network will be more effective when integration is attained through centralization, when mechanisms of external control are direct and unfragmented, when conditions for development are more or less stable, and when resources are available in the environment.

Despite the fact that the growing literature on public management networks suffers from an imbalance due to the abundance of static network studies, recent years have seen the first attempts to understand the evolution of selected structural aspects of public management networks over time (Isett & Provan, 2005; Milward, Provan, Fish, Isett, & Huang, 2010; Provan et al., 2009; Provan, Isett, & Milward, 2004). Provan, Isett, & Milward (2004) examined the impact of conflicting institutional pressures on the evolution of one community mental health system and how its key organizations responded to these pressures by developing a network response. They concluded that collaboration was accompanied by increased centralization, a greater number of ties and
greater strength of the multiplexity of ties over time. Similarly, Isett and Provan (2005) found that the multiplexity and embeddedness of ties in a network of publicly funded health and human services agencies tends to increase over time, whereas the formality of those ties tends to stay on the same level, which is contrary to the “familiarity breeds trust” argument (Gulati, 1995). Provan et al (2009) developed and tested specific hypotheses linking evolution and network structure. The results of the study indicate that structural embeddedness in the network or network involvement positively predicts social indicators of trustworthiness, reputation, and influence, with this relationship being stronger as a network develops over time. Milward, Provan, et al. (2010) compared the evolution of two community mental health networks over time and across two networks using the structure of the network, the type of sector (nonprofit or for-profit), relationship and trust, and network performance. The results of this study are limited because it links only the importance of the formal structure of the network for effectiveness to the importance of previous ties with service providers for a higher level of trustworthiness. The conclusion of the study, however, deserves close attention by public administration practitioners in that network outcomes appear to be similar between providers irrespective of the networks.

Of the abovementioned four studies, however, none address the complexity and multi-faceted nature of networks nor simplify the modeling for the convenience of researchers. This is due to the difficulty of collecting longitudinal data from public sector networks. Like static studies in public policy and management networks, these evolutionary studies (Isett & Provan, 2005; Milward et al., 2010; Provan et al., 2009; Provan, Lamb, et al., 2004) suffer from a level-one theory problem, meaning that these
studies are focused on one level of the networks and employ only one established theory, normally derived from sociology and organizational theory. None of the existing longitudinal studies of public management networks has identified the main stages of development or the evolution of public management networks nor the processes that are predominant at each particular stage of development. Research on the structural tendencies of public management networks at each stage of network development is practically nonexistent, except for some structural postulates of network effectiveness at the implementation stage of execution articulated by Provan and Milward (1995). Even though the process models for developing and managing public networks emphasizes the various functions that need to be performed by managers, existing longitudinal studies of public management networks appear to focus on the organizational characteristics that determine network structures. These studies meanwhile manage to ignore the effects of the characteristics of individual network actors such as gender, organizational network experience or previous relationships on the structural configurations of networks at the different stages of network development. However, it is high time for “bringing the individual back in[to]” network studies (Kilduff & Krackhardt, 1994, p. 87).

The present research is carried out in the tradition of “opening the black box” of public management networks by identifying structural configurations in the various stages of network development. Little research has examined how public management networks are structured at the different network levels over time, depending on the initial conditions such as pre-network ties or capacity for organizational networking (Provan et al., 2009). By the different levels, I mean the level of the whole network (global level), dyadic level, triadic level and the individual network actor (an organization or an
individual representing an organization in the network). Therefore, it is necessary to offer insights into the structural dimensions of network evolution to facilitate the development of network theory and to develop practical recommendations for public managers embarking on the path of the “network manager.”

The present research has potential theoretical and practical contributions to the field of public management. From a theoretical perspective, the research contributes to theory building in the field of public management by developing testable structural hypotheses that can explain the development of public management networks. By now, public management network research had been flooded with one- or two-network case studies using descriptive network analyses and calls for predictive models linking network performance and structural and process antecedents of network performance. The present research also has a potential value for policy makers, public managers and public program evaluators who evaluate the efficiency and effectiveness of networks as responses to complex and “wicked” problems (Rittel & Webber, 1973). The conceptual and methodological framework on the structural configurations of public management networks in the various stages of development can be used by policy analysts and public program evaluators to understand, measure, and evaluate the main aspects of network effectiveness using statistically robust approaches in network modeling. Ventriss & Gurdon (2006, p. 46) state that this kind of analysis would help policy makers and public managers to understand the management of organizational interdependencies so that “the rich network of institutions will become essential in mobilizing the intersectoral actors in implementing policy goals” (p. 46).
1.2 Research questions

The main goal of the dissertation is to develop and test a conceptual framework of the structural development of public management networks over time. The present research has three foci: it offers a framework of structural tendencies of public management network organizations using a multitheoretical, multilevel approach (Contractor, Wasserman, & Faust, 2006) with a dynamic perspective; it suggests propositions about structural configurations of public management networks in the different stages of network development; and it tests suggested propositions regarding structural tendencies of public management networks over time. Therefore, the present research is intended to answer the following questions, which are both practically and theoretically important, and it moves away from traditionally adopted public administration approaches that describe and explore network processes at one level and use one theory and instead confirms and makes inferences using multiple theories and different levels of the network.

Using the case of Metro High School in Columbus, Ohio, I test a theoretical framework of the structural development of public management networks over time using different theories at the different levels of the network:

1. What processes are predominant at each stage in the evolution of public management networks?

2. What are the structural configurations of public management networks in the different stages of network development at different levels of the network (actor, dyadic, triadic and global levels)?
3. What is the effect of the individual characteristics of the network actors such as gender, sector affiliation and interorganizational network experience on the structural configurations of public management networks over time?

The present research aims to develop a theoretical framework that clearly explains the structural development of public management networks over time using sociological, organizational and public management theories at the different levels of the network. Contractor, Wasserman and Faust (2006) clearly suggest “a more theoretically and methodologically sophisticated approach to explaining the emergence of networks” (pp. 700-701). With that being said, it is necessary to note that I am not directly applying or testing the multitheoretical, multilevel framework developed by Contractor, Wasserman and Faust (2006) in the setting of public management networks. On the contrary, I’m using the Contractor, Wasserman and Faust (2006) framework as a methodological guide to develop and expand a theory of structural development of public management networks over time.

The study employs a mixed-methods approach to develop empirical assessments of structural configurations of network development over time. It uses a longitudinal case study that combines quantitative and qualitative data from two different points of time (the planning stage and the implementation stage) during the Metro High School project, where different levels of analysis (at the level of the whole network, triadic, dyadic and individual actor levels) are used to develop a global and “thick” picture of the whole. Metro High School is a landmark STEM (Science, Technology, Engineering and Math) high school in Columbus, Ohio, which opened its doors in the fall of 2006. It was launched concurrently with a special initiative of the state of Ohio to expand the state’s
technological infrastructure and to facilitate new high-tech research, business development, and job growth across the state. This school is an exemplary instance of STEM programming that is based on public/private partnerships and supported by community learning. The Metro High School project is a suitable case to answer the research questions since Metro is both a formal, networked structure and a collection of informal relationships at the individual level that transcend organizational, governmental, and sectoral boundaries.

1.3 Organization of the thesis

The study consists of seven chapters. In this first chapter, I identify the gap in network literature regarding the evolution of public management networks and justify the proposed research by identifying the potential theoretical and practical contributions of the study for public management and policy analysis practitioners and academicians. In the second chapter, I will provide an overview of the main concepts of social networks and theories of network development related to the proposed research. The third chapter outlines the theory of structural development of public management networks based on the concepts and theories outlined in the second chapter. The proposed theory is represented as a set of structural hypotheses describing the development of networks over time based on the multitheoretical, mutlilevel modeling approach (Contractor et al., 2006) and incorporates relevant sociological, organization science and public management theories. The fourth chapter covers data description and methodology, explaining the selection of the longitudinal case-study design as well as providing details about each
step of the data collection, data production and analysis. The fifth chapter describes the case of Metro High School network and identifies the processes predominant in each stage of development in the evolution of public management networks. The sixth chapter is devoted to testing the theoretical framework of the structural development of public management networks described in chapter 3. Finally, the last chapter focuses primarily on a discussion of the conclusions and implications of the research findings and the limitations of the study. In this chapter I review the main analytical findings of the Metro High School case study as well as the results of testing my model of the structural aspects of development of public management networks. I also provide guidelines for public program evaluators as to how to use this kind of modeling to assess the effectiveness of public management networks. Finally, limitations and implications for future research are also provided.
CHAPTER 2 : REVIEW OF KEY NETWORK CONCEPTS AND THEORIES OF NETWORK DEVELOPMENT

A literature review of research on public management networks shows that public management scholars are, first of all, interested in the processes leading to the development and management of public management networks (PMNs). They are also interested in the structural aspects of public management networks and their effect on the performance and effectiveness of those networks. How do networks evolve? What are the antecedents of public management networks? What are the different structural configurations of public management networks?

In this chapter, I cover and explore the theoretical frameworks that can be used to explain the structural development of public management networks over time. Firstly, I provide a review of theories that explain the emergence and development of public management networks, such as resource dependency theory, population ecology, transaction cost economics, and organizational change theories. Secondly, I provide a description of the essential concepts of social network analysis that allow one to look at a network both as a system (and subsystems) and as relationships at the nested level. I review the concepts of social network analysis using the different levels of analysis that are conventionally accepted in the community of social network analysts: individual actor level, tie level (dyad and triad levels), subgroup, and whole network or global level (Wasserman & Faust, 1994).
2.1 Process of network formation and development

Public management networks emerge as a response to “wicked policy” problems and sometimes as the legal and mandatory requirement for addressing complex issues. No single theory can best explain the formation and development of public management networks. However, a broader view of organizational theory literature suggests several potential explanations for network formation and further development: resource dependency theory, population ecology, transaction cost economics and that popular set of organizational change theories including life-cycle, teleological and dialectical theories.

Resource Dependency Theory

Resource dependency theory suggests that organizations secure the stable flow of resources to survive in different environments. Interorganizational cooperation can be explained in terms of the critical resources necessary for the effective functioning and survival of the participating organizations. According to resource dependency theory, every organization is dependent on those organizations or agencies that control resources that are vital for the existence and effective operations of that organization (Pfeffer & Salancik, 2003). Therefore, organizations form in networks to secure vital resources to execute their operations. It is worthwhile noting that these resources can not only be material but also symbolic, especially if they are related to reputation, trust, prestige and legitimacy (Hardy & Phillips, 1998).

Pfeffer and Salancik (2003) distinguish two mechanisms for structuring organizational resources: network extension and network consolidation. Through network
extensions, organizations can increase the number of connections with different resource providers and thus establish network connections. Through network consolidation, organizations decrease the number of resource providers by creating coalitions with other resources providers.

From a social network analysis perspective, resource dependency is necessary for any organization that wants to manage its ties with stakeholders so that the total portfolio of its ties is optimal for achieving organizational goals. Mere interconnectedness, without strong network ties, is no longer sufficient for organizational survival in the long run (Uzzi, 1996). Moreover, organizations can gain a financial advantage by forming synergetic alliances that change the pattern of dependencies in their respected environment (Larson, 1992).

**Population ecology**

Population ecology seeks to explain the birth and death of organizations as well as the factors affecting stages of organizational life. Specifically it attempts to explain factors affecting the rate of organizational birth and death in the population of organizations competing for the same resources. The theory of population ecology is the social extension of Neo-Darwinism and genetic schools and is based on the biological principles of variation, selection and retention where genetic variations lead to processes of mutation and natural selection of the fittest (Hatch & Cunliffe, 1997)

Baum (1996) neatly summarized three fundamental processes in the study of population ecology research: demographical processes, ecological processes and environmental processes. Demographical processes research looks at age and size
dependencies, suggesting that younger and smaller organizations are more prone to
demise and organizational death unless roles and routines within organizations are
established and linkages with stakeholders are strengthened (Freeman, Carroll, &
Hannan, 1983). Ecological processes are related to niche-width dynamics, population
dynamics, density dependence and community interdependence, including symbiosis and
competition. Environmental processes include: institutional processes (political upheaval,
for example), government regulations, technological processes and institutional changes.
Technological processes, for example, affect the development of new organizations and
determine survival rates. Thus, the political, economic, social, technical, and legal
characteristics of the environment affect organizational birth and death, since
organizations are not always capable of coping with rising environmental complexity.

The central ideas of population ecology such as legitimacy, competition and niche
are essential for explaining network formation and the effective management of public
management networks. The legitimacy of an organization can be promoted by its network
connections in the market (Hannan & Freeman, 1977; Podolny, 1993). Similarly, the idea
of competition in population ecology is compatible with the concept of structural
equivalence in the network. When organizations share “common” forms it means they are
structurally equivalent (Kilduff & Tsai, 2003). In addition, the position of the market in
relation to a network is very similar to the idea of the niche in population ecology (Burt,

The theory of population ecology rests on three evolutionary principles: variation,
selection and retention. Variation of organizational forms can be of two types: “blind”
and “intentional” (Aldrich, 1999). Blind variations create new organizational forms by
chance and are similar to biological mutations. Intentional variations occur during the process of problem solving and developing new products and services as the result of entrepreneurship. Selection operates on variations and is carried out through “the operation of market forces, competitive pressures, the logic of internal structuring, conformity to institutionalized norms and other forces” (Aldrich, 1999, p. 26). As competition intensifies, organizations become engaged in the processes of mutualism and symbiosis by developing networks of relations among each other. Thus, organizations form internal network structures that replace external dependencies but increase their internal complexities. Retention occurs when a variation selected by the environment becomes part and parcel of an organization, a mundane routine, innovative practice or competitive advantage. Two types of innovations are distinguished here, incremental and radical (Tushman & Romanelli, 1985). Most organizational innovations tend to be incremental and aimed at improving organizations, whereas radical innovations transform the whole of nature of operations in the organization.

**Organizational change theories**

Most of the process theories in organizational studies were described by van de Ven and Poole (1995) in their seminal article summarizing all types of process theories and theories of an organization’s development. They define development as “a change process (i.e., a progression of change events that unfold during the duration of an entity’s existence—from the initiation or onset of the entity to its end or termination)” (Van de Ven & Poole, 1995, p. 512). These authors distinguish four types of process theories: life cycle (linear sequential), teleological (repetitive circular), dialectical (based on the
principal of Hegelian philosophy) and evolutionary (based on the ideas of Darwinism). Figure 1 shows a summary of each theory. Since population ecology is an evolutionary theory and was discussed in the previous section, I will concentrate on the life cycle, teleological and dialectical theories.

![Figure 2.1: Process Theories of Organizational Development and Change](image)


Life cycle theory equates an organization to a biological organism, in that “the developing entity has within it an underlying form, logic, program, or code that regulates
the process of change and moves the entity from a given point of departure toward a subsequent end that is prefigured in the present state” (van de Ven & Poole, 1995, p. 515). This theory describes inevitable linear sequences of at least three stages: emergence, evolution and termination. Some interorganizational scholars state that in the evolution stage of collaborative networks, actors are engaged in learning about successes and failures of collaboration during the process of implementation. This learning process may result in changing the original plans and operations or even network termination (Kanter, 1994; Larson, 1992; Lowndes & Skelcher, 1998).

The public management literature on collaborative governance and public management networks does not provide many examples of life cycle theory. Having examined the governance of organizational networks and the impact of governance on network effectiveness, Provan and Kenis (2008) suggested a life cycle development of public management networks where the networks are “likely to evolve in a predictable pattern from the shared governance to a more brokered form and participant governed to externally (NAO) governed (p. 246).”

Teleological theory assumes that organizations are purposeful and adaptive and that, either alone or by interacting with other organizations, they should reach a particular projected state of being by taking appropriate actions and monitoring the progress (Van de Ven & Poole, 1995). According to teleological theory, the development of organizational forms comes about through a repetitive sequence of goal formulation, implementation and modifications as needed. This theory does not impose any prescribed sequence of stages, but there is one requirement, which is reaching the final goal or end state. The theory assumes a highly rational behavior on behalf of the actor, a purposefully
driven behavior to achieve goals that are socially constructed and subject to change. Teleological theory also recognizes the limiting role of organizational environments and the importance of environmental scanning for taking full advantage of environmental factors.

Goal oriented and cyclical approaches to the development of interorganizational networks assume that interorganizational partnerships and networks are developed through sequences of negotiation and commitment as well as through the development of rules for how to collaborate and operate within the network (Doz, 1996; Ring & van de Ven, 1992, 1994). Ring and van de Ven (1994) propose the model of network development as a reiterative cycle of negotiations, commitment and execution. Each stage consists of a series of interactions, the outcomes of which are assessed in terms of efficiency and equity. Doz (1996) suggests that the evolution of strategic alliances goes through a sequence of learning-reevaluation-readjustment cycles, which can have a positive and cumulative impact on commitment to the relationship. The importance of learning throughout the whole sequence of reiterations is also emphasized by Weiss and Visioni (2003).

Dialectical theory assumes that organizations are positioned in a world of opposing forces, values and events competing with each other. Stability and change depend on the balance of power between colliding forces, events and values. According to dialectical theory, organizational development or change takes place when the status quo is challenged by more powerful opposing forces, events and values. The process of development in the dialectical approach is explained in Hegelian terms of thesis, antithesis and synthesis. Every new state or stage of organizational development would
be best described as a synthesis that has emerged as a result of the struggle of thesis and antithesis embodied by opposing forces, events and values. In public administration literature, this approach was introduced by Nutt and Backoff (1992) at the strategy level as one of the approaches to develop strategies in the public and nonprofit sectors.

The dialectical approach to network development has been explored by Benson (1975), who describes an interorganizational network as a “political economy concerned with the distribution of two scarce resources, money and authority” (p. 229). Benson argues that the flow of resources is contingent on developments in the external environment by entities such as authorities, legislative bodies, bureaus, and the general public. Very recently, Saz-Carranza and Longo (2012, January) applied the dialectical approach to the evolution of governance networks in the public sector to explain the development of the European regulatory network. They conclude that dialectical theory is useful for explaining the tensions between hierarchy as a coordination mechanism and informal and decentralized networks, tensions that trigger further development of governance networks.

**Transaction Cost Economics**

The transaction cost economic approach uses the study of economics to provide an explanation for network formation and development. This approach was developed in opposition to traditional economic theory, which promotes the idea of the market as “classical organizational form, where buyers and sellers communicated their intentions to each other, and where supply and demand were presumed to determine prices for good” (Monge & Contractor, 2003, p. 150). While the traditional theory of economics focuses
primarily on production costs, transaction cost economics focuses on the costs related to searching for information and negotiating about the price and quality of goods and services that serve as inputs in the production process of organizations (Williamson, 1975, 1985). Conversely, representatives of neoclassical economics praise organizational “hierarchical and vertically integrated forms as a more efficient alternative to markets” (Jablin & Putnam, 2001, p. 454). Thus, managers of organizations face the “make or buy” dilemma. Organizations can either buy goods and services from other firms or purchase firms that produce those goods and services. Williamson (1985) argues that efficient organizations should minimize transaction costs by choosing between markets and hierarchies. Networks emerge as an alternative to markets and organizational hierarchies and serve as a hybrid organizational form that incorporates the best features of markets and organizational hierarchies (Powell, 1990).

Nevertheless, the decision between minimizing the transactional costs of finding good prices and quality from resource providers and the administrative costs of maintaining hierarchy can influence the formation of particular types of networks. If an organization decides to rely on the market form of producing goods and services, then this organization has to develop and maintain comprehensive external networks for obtaining and assessing information about the resource suppliers, negotiating contracts and monitoring performance. If an organization decides to adopt a hierarchical form, the organization has to develop and maintain comprehensive internal networks for integrating purchased firms that provide parts, raw resources and components for the production of goods and services (Monge & Contractor, 2003)
The original ideas of the transaction cost economics approach were critiqued by Zajac and Olsen (1993) for ignoring communication and other processes occurring in the transaction cost analysis. Zajac and Olsen (1993) proposed a three-stage process where two or more organizations can decide if they want to pursue an organizational partnership. During the first stage, called “initializing,” organizations develop their strategic plans, assess their exchange alternatives and start interorganizational exchange. Particularly, they are involved in the “process of projecting exchange into the future” (Macneil, 1983) and constructing net present valuations of alternative exchange relationships on a continuum ranging from markets, through interorganizational strategies, to hierarchies “(Zajac & Olsen, 1993, p. 139). The first rounds of exchange are included in this stage as well and “take the form of preliminary communication and negotiation concerning mutual and individual firm interests, and/or feasibility studies and general information exchange” (p.139). The second stage is called the “processing” stage, where organizations are involved in the serial and parallel processes of exchange (Monge & Contractor, 2003). A serial process of exchange involves “a series of discrete transactions through a single channel of exchange extending over the course of the forecast period,” whereas a parallel process is one in which “the exchange occurs simultaneously over several channels of interdependent exchange over the course of the forecast period” “(Zajac & Olsen, 1993, p. 140) As in the first stage, learning takes places in this stage, giving rise to “associations, cognitive systems, and memories” (Fiol & Lyles, 1985, p. 804). Trust also develops in the processing stage based on the expectations of stable interactions with another organization over a long period of time. Finally, the third stage, called “reconfiguration,” is characterized by the evaluation of the
interorganizational relationship and a decision about whether to make any changes in the relationship, either by exiting the partnership or by engaging in even more parallel interorganizational exchanges. If the latter, information and communication network relations would be strengthened, and more stable organizational forms may emerge, such as joint venture.

In sum, the theories presented here, explaining the evolution of public management networks, are keys for prescribing effective network management mechanisms. However, each of these theories presents a fragmented view of the whole process of network formation and virtually ignores the structural aspects of network development. For instance, none mention the particular structural characteristics of a network such as density, centrality, reciprocity, transitivity, structural holes or number of cliques. The next section is devoted to explaining the most widely used structural characteristics of networks found in the organizational theory literature of both public and general management fields.

2.2 Social structuring of public management networks

A great deal of existing public management network research is concerned with investigating the social structures that emerge as a result of the interactions between public, nonprofit and private organizations. Social structures are defined as “patterns of connectivity and cleavage within social systems” (Wellman, 1988, p. 26). Studying social structures allows one to compare emerging public management networks and to detect the differences between the observed networks and structures developed theoretically
(Barley, 1990). The analysis of the social structures in public management networks can look at a network both as a system and subsystems as well as relationships at the nested level. This kind of analysis can “trace lateral and vertical flows of information, identify sources and targets, and detect structural constraints operating on flows of resources” (Wellman, 1988, p. 26). Using social structure analysis (Wasserman & Faust, 1994), one can see the different types of relationship among the network actors, the strength of relationships, power and authority distribution and availability of resources.

Public management and policy networks are characterized by “high levels of interdependence involving multiple organizations, where formal lines of authority are blurred and where diverse policy actors are knitted together to focus on common problems” (Schneider, Scholz, Lubell, Mindruta, & Edwardsen, 2003, pp. 143-144). These interdependencies, therefore, can be studied through a number of social analysis concepts: reciprocity, density, bridging and bonding. As mentioned previously, organizational networks can be studied at different levels: individual actor level, tie level (dyad and triad levels), subgroup, and whole network or global level (Wasserman & Faust, 1994). In public management network research, the individual actor level is traditionally represented by organizations from various sectors whether public, private or nonprofit as units of observation. However, the individual actor level can also be represented by groups and individuals within the organizations constituting the interorganizational networks. Tie level is represented by dyad and triad levels of network. At the dyad level, organizational network researchers examine the relationship between two network actors, whether this relationship is reciprocated or not. At the triadic level, three nodes and relationships among actors are examined, especially in terms of balance.
and network transitivity. Researchers may investigate the different types of triads that describe the inclination of a network for hierarchy, flow of resources and distribution of power in the network.

At the subgroup level, an organizational researcher investigates the membership in the different subgroups and the characteristics of the members belonging to these subgroups (Monge & Contractor, 2003). Finally, global or whole-network-level research looks at the properties of the whole network such as network centralization, network density, network reachability and network balance. Each of these properties can point to the characteristics that are essential for understanding the effectiveness of a public management network. For example, highly centralized informal relations in a public management network may indicate the mechanistic nature of the organizations constituting this network. Similarly, an interorganizational network with multiple centers in the network of informal relations indicates the organic nature of organizing in this network (Shrader, Lincoln, & Hoffman, 1989).

**Individual actor level concepts**

Individual actor level concepts include degree, indegree and outdegree centrality, eigenvector centrality, betweenness centrality, closeness centrality, structural holes and homophily. Each of these represents the important structural characteristics of a network that can be modeled and linked to particular social, organizational and public management theories.

Degree, indegree and outdegree centrality is measured by the numbers of ties held by one particular node (Wasserman & Faust, 1994). In a directed network, the number of
ties coming out of a node or a network actor is defined as outdegree centrality. Similarly, the number of ties coming to a node or a network actor is called indegree centrality. In undirected networks, the number of ties held by a particular node or network actor is called degree centrality.

The degree centrality of a node can be interpreted differently in various contexts and have both positive and negative meanings, contingent on the context (Monge & Contractor, 2003). In a communication network, a high outdegree centrality points at the “expansiveness” of a particular node, whereas a high indegree centrality serves as a proxy of particular actor. One popular use of degree centrality is the measure of social capital at the individual level. Emergency management scholars view degree centrality as the degree of responsiveness of an organization to natural disasters (Kapucu, Augustin, & Garayev, 2009). Monge and Contractor (2004) argue that high degree centrality can also be interpreted as “communication overload or a constraint on the node’s ability to function effectively” (p. 38).

Eigenvector centrality is based on degree centrality and is calculated by summing all ties of one network actor to other actors, weighted by their degree of centrality (Wasserman & Faust, 1994). The network actor is considered to be central if he or she has more direct or indirect connections to the most popular actors in the network. Since eigenvector centrality is based on degree centrality, it can produce the same results as degree centrality. Eigenvector centrality serves as a measure of the popularity of a network actor.

Betweenness centrality measures the degree to which a network actor is directly connected to those nodes in the network that happen not to be connected directly to each
other (Wasserman & Faust, 1994). It also measures the degree to which one particular node serves as a bridging point among different network actors. The interpretation of betweenness centrality is again contingent on the context. In communication networks, the high betweenness centrality of a particular network actor defines the gatekeeper position that controls or brokers the information flow or even imposes particular meanings on data. In interorganizational networks, betweenness centrality indicates the position of liason between individuals, groups and organizations that are not connected directly. If such a liason person, group or organization is eliminated from the network, it may lead to disconnection of subnetworks that are not connected directly. As in the case of degree centrality, betweenness centrality is used as a structural characteristic to define the performance of emergency management networks. Kapucu (2009) found that low scores in betweenness centrality indicate a low communication dependency of network actors on other organizations.

Closeness centrality measures “the extent to which nodes are directly or indirectly connected to all other nodes in the network” (Monge & Contractor, 2003, p. 38), and can be considered a global network measure since all network ties are taken into account to calculate it. If degree centrality measures the activity performed by a particular node, if betweenness centrality measures the control over the flow of information, then closeness centrality shows the independence of a particular network actor from other network actors (Prell, 2012). The independent actor has the shortest path lengths to other network actors, so this actor has no need to “rely on others to relay messages through the network” (Prell, 2012, p. 107). Therefore, high closeness centrality can serve as a proxy
for the reachability of a particular network actor. In other words, closeness centrality allows for the assessment of the indirect reach of a network actor.

Social network researchers have developed different interpretations for closeness centrality. Some researchers view closeness centrality as the potential to mobilize the whole network when needed (Prell, 2012). Some researchers believe that closeness centrality shows how easily a particular network actor can access information in the network (Leavitt, 1951). Finally, some researchers believe that closeness centrality can be a proxy for power (Coleman, 1973) and influence (Friedkin, 1991). In the emergency management literature, closeness centrality is used as the measure of an organization’s responsiveness to natural disasters (Kapucu, 2005).

Structural holes allow network actors to have a structural advantage over other network actors. The notion of structural holes was introduced by Ronald Burt, who defined structural holes as “the empty spaces in the social structure” (Burt, 2005, p. 16). Structural holes are traditionally present in egocentric networks, which are based on the perceptions and self-reported answers of the respondents. The respondents are called “egos” and reported connections are called “alters.” The concept of structural holes in essence defines the position of a broker who connects subnetworks and unconnected individuals and who benefits from this position. The idea of structural holes is tightly connected with the concept of social capital. After all, those who connect the unconnected part of the network such as subnetworks, cliques and unconnected individuals can take structural advantage by gaining access to coveted information, untapped organizational resources, and career opportunities and by forming coalitions for

Burt conducted a number of studies showing the link between filling a structural hole and different organizational outcomes such as higher profits, better salaries and innovative ideas (Burt, 1976, 1992, 2001, 2004, 2005). Other researchers have used Burt’s research agenda to investigate the effect of structural holes on the innovative capacity of organizations (Ahuja, 2000), attaining status in organizations (Lin, 1999) and the results of performance evaluation (Mehra, Kilduff, & Brass, 2001).

Homophily is defined as “the degree to which pairs of individuals who interact are similar in identity or organizational group affiliations” (Ibarra, 1993, p. 61). The emergence of homophily may depend on either the organizational setting or on social identity. Coleman (1961) and Feld (1981, 1982) argue that the formation of ties among similar network actors is contingent on the organizational setting. For example, individuals with high levels of altruism tend to join nonprofit organizations since similarity in values will most likely influence other similarities among actors. Other examples of organizations are churches, sports clubs, bowling groups, etc. Skvoretz (1985, 1990), however, argues that organizational settings have nothing to do with the formation of homophilic ties. Network actors just look for and find other network actors based on social, cultural and demographic similarities irrespective of the organizational setting. For example, friendship ties in an organization may be formed based on age or educational background similarities.

Homophily helps to explain the formation of gender networks within organizational and interorganizational settings. According to Ibarra (1993, 1997), men
are more likely to form homophilous ties across multiple networks and have stronger homophilous ties. And these networks tend to be detrimental for women and beneficial to men because of their tendency to be homophilous. By comparison, Ibarra (1992) argues that women’s networks have a different pattern in terms of homophily, that women are inclined to form differentiated networks in which they obtain “social support and friendship from women and instrumental access through network ties to men” (p. 422). In addition, men gain the more benefits from homophilous relationships along with individual and positional resources compared to women.

From a public management and public policy perspective, homophily can be useful to explain the formation of public management networks. Provan and Kenis (2008) argue that interorganizational collaboration and the formation of public management networks can be explained by the similarities of organizations and their representatives. However, it is still unknown whether it is the similarity of organizational goals or the instrumental reasons of individuals that is most important. Surprisingly, Newman and Dale (2007) recommend preventing homophily in sustainable development networks. They argue that, given the fact that networks tend to gravitate toward and increase homophily over time, and that homophily decreases the diversity of network actors in the sustainable development network, this in turn reduces the network resilience and stability.

**Tie-level concepts**

Tie level concepts include the strength of a tie, reciprocity, multiplexity, triadic relationships and Simmelian ties. Each of these represents the important structural
characteristics of a network that can be modeled and linked to particular social, organizational and public management theories.

The strength of a tie is a concept coined by Granovetter (1973) and is defined as a “combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie” (p. 1361). According to Granovetter (1973) ties can be either strong or weak. Strong ties are exemplified by long-time, frequent relationships such as close friendship ties where friends interact with each other on a frequent basis. Weak ties, on the contrary, are characterized by infrequency, fluidity and distance, but they also happen to be more valuable in terms of obtaining diverse information and bridging the gaps between cliques in the network. Therefore, weak ties are more likely to provide career opportunities for people in the network than are the strong ties of friendship and kinship. Recent research, however, suggests that particular types of strong ties are necessary for transmitting the complex knowledge in the network (Hansen, 1999).

From a public management and public policy perspective, weak ties function as bridges for fragmented subnetworks (cliques, for example), which subsequently unite and organize those subnetworks for solving collective action problems (Kilduff & Tsai, 2003). The number of weak ties in public management networks can also serve as a structural indicator of a particular stage of network development and network effectiveness. Provan and Milward (2001) state that the early stages of network development are characterised by a multiplicity of weak ties, some of which tend to disappear as public management networks evolve.
Reciprocity or mutuality is defined by the number of symmetric ties among the network actors. There are three types of directional ties that may exist between any two individuals: null, symmetric and asymmetric (Wasserman & Faust, 1994). Null relations are characterized by the absence of relations between two nodes in the network. Symmetric ties exist when two network actors have ties to each other. Asymmetric ties are characterized by a situation where a tie exists only between two network actors. For example, one network actor sends information to another actor, but the other actor does not send any information back. Friendship relations usually tend to be symmetric, and even if they are asymmetric there is always a pressure to transform them into the symmetric by breaking other ties or reestablishing the lost connection (Kilduff & Tsai, 2003). Power and influence relationships are usually characterized by asymmetry (De Soto, 1960).

Reciprocity, as a structural characteristic of a network, explains the degree of resource exchange in the network from a theoretical point of view. Social exchange theory, as developed by Homans (1950, 1974) and Blau (1964), stipulates that human relations can be explained by the weighing up of resource exchanges such as information and resources. Therefore, building and maintaining network ties is conditioned on reciprocity of exchanging resources (Willer & Skvoretz, 1997). For example, if network actor A provides information to actor B, he/she expects actor B to reciprocate and provide information back. The research also suggests that the exchange of resources is limited to one-to-one types of exchanges. For example, someone who receives one type of resource such as information may reciprocate by providing advice or support (Rank, Robins, & Pattison, 2010).
Multiplexity of ties refers to the number of different relations between two network actors. For example, two network actors can be friends and plan network activities together, thus being engaged in the multiplex relationship. Multiplexity of ties allows measuring the “multiplicity of interests” (Barnes, 1979, p. 412) and assigning the value of ties based on the number of interests. The higher value of a tie indicates the greater difficulty in breaking that particular tie since people are “bound to each other in the different social arenas” (Kilduff & Tsai, 2003, p. 33).

Multiplexity of ties is another structural measure which shows the development of public management networks over time as well as the development of trust. Having studied the evolution of one community mental health system, Provan, Isett, & Milward (2004) came to the conclusion that the number of ties and the strengths of the multiplexity of the ties increases over time. In another study, Isett and Provan (2005) found that although multiplexity and embeddedness of ties in a network of publicly funded health and human services agencies tends to increase over time, there is not necessarily a decrease in formal ties at the same time. Multiplexity of ties can be also interpreted as a measure of trust in the network. If network actors are bound by different multiplex relations, they are predicted to have more trust and commitment between them because of the strong embeddedness of their operations with each other (Granovetter, 1985; Uzzi, 1997). It is necessary to note that the evolution of public management networks is not accompanied by the transformation of formal or contractual ties into informal ties, which allows for the building of trust among network actors. Unlike in private sector networks, formal ties in public management networks become strengthened
over time, alongside the development of informal ties such as referrals (Isett & Provan, 2005).

The triad is another structural characteristic in network analysis that depicts relationships between three network actors, and which is almost completely underutilized in public management research. A triad is the totality of links between three actors (or a triple). Three network actors constituting a triad without ties is called triple (Wasserman & Faust, 1994). When we add ties to a dyad, it becomes a triad. If dyadic relationships include three types of relations—mutual, asymmetric and null—triad configurations encompass up to sixteen types of triads, essential for testing various structural hypotheses about network development, structuring and performance. These sixteen triads range from completely “null” triads to completely mutual triads. The triad without any ties between three network actors constituting a triad is called a completely null triad. If all three network actors constituting a triad are connected by mutual ties, then this type of triad is called a completely mutual triad. Each of these types of triads is used in the triadic census analysis, which allows researchers to test various structural hypotheses and links the structural properties of a network to particular network theories.

A triadic census analyzes the various triadic network configurations that influence the probability that ties will be present or absent in the network (Contractor et al., 2006). As Wasserman and Faust (1994) argue, there is considerably more that we can learn from a count of triads, known as a triadic census, because the analysis does not condense the original data as much as a dyad census: a triadic census analysis has sixteen components rather than the three components that can be found in a dyadic census.
Researchers analyzing the sixteen components, or isomorphic classes, in a triadic census use a labeling scheme that highlights the dyadic states contained within the triad. For example, on the one hand, a triad could theoretically contain no linkages among the three actors, such that there would be zero mutual (connected in both directions) dyads in the triad, zero asymmetric (connected in one direction) dyads in the triad, and three null (no connection) dyads in the triad. This triad is labeled as a —003 triad class with the three characters signifying mutual, asymmetric, and null dyadic states. In the other extreme, a triad could consist of complete mutuality (three mutual dyads) with no asymmetric or null dyads. This triad class is labeled as a —300. Since there are a total of sixteen such classes, the labeling scheme can include labels such as —201 (two mutual, zero asymmetric, and one null dyads) or —210 (two mutual, one asymmetric, and zero null dyads). Thus, the triadic census is an expedient way to reduce an entire sociomatrix to a smaller set of sixteen summary statistics with which to test various structural hypotheses related to structural balance, resource exchange and transitivity.

Transitive and cyclical triads are of particular interest for researchers investigating the structural aspects of interorganizational and interpersonal networks. Transitive triads occur when a network actor A has a connection or tie to a network actor B, a network actor B extends a tie to a network actor C and network actor A is in turn connected to a network actor C. From a theoretical point of view, transitive triads can be interpreted differently depending on the substantive nature of the relations. According to theories of cognitive balance (Heider, 1958; Holland & Leinhardt, 1975, 1981), friends prefer that their friendship ties be reciprocated so that their friends should be friends with each other. Therefore, if person A is friends with person B, person B is friends with person C, then
there is a pressure for person A to be friends with person C. Related to this, people prefer choosing friends based on a strong compatibility of beliefs, values and interests. This value and belief compatibility in transitive triads has particular implications for developing collaborative ties in the process of forming public management networks as well as for reinforcing trust as public management networks evolve (Henry, Lubell, & McCoy, 2011). Transitive triads in formal relationships within organizational and interorganizational networks point at the presence of hierarchy or vertical integration where one can see a clear chain of command. In other words, there is a boss for every boss and there is a clear line of subordination (Contractor et al., 2006). In team-based organizations, the hierarchy is based on differentiation and caused by specialization, responsibility, and delegation of authority for making decisions.

Cyclical triads are triads with ties connecting network actors in a clockwise order. Network actor A has a tie to network actor B, network actor B sends a tie to network actor C and finally network actor C has a tie to network actor A, thus finishing the cycle (Wasserman & Faust, 1994). Similar to transitive triads, cyclical triads can be interpreted based on the nature of the relationship (Contractor et al., 2006). When network participants are involved in exchanging resources, i.e., providing information, receiving information, or giving advice, then these kind of relationships can be explained by the theory of generalized exchange (Bearman, 1997).

Simmelian ties are dyadic relationships between two network actors belonging to the same clique. Krackhardt (1999) defines Simmelian ties as ties between two people who “are reciprocally and strongly tied to each other and . . . each reciprocally and strongly tied to at least one third party in common” (p. 186). Initially, these ties were
described by Georg Simmel, the German sociologist who discussed the differences between triadic relationships and dyadic relationships. Later, Krackhardt (1999) described Simmelian ties as relationships between two network actors embedded in the clique, where the norms of the clique determine the behavior in the dyads. Being embedded in the clique, these dyadic relationships are restrained in terms of attitudes and behaviors because the triadic relationship in the clique represses the interests of each network actor in the dyad, weakening the individual bases of power of each of the network actors as well as moderating the conflict.

Simmelian ties have several important implications for public policy and public management networks from the evolutionary perspective. First, Simmelian ties tend to be more stable over time than non-Simmelian ties (Krackhardt, 1998) since they tend to be “strong and sticky” (Krackhardt, 1998, p. 21). Secondly, network actors tied by Simmelian ties tend to share similar views on organizational and social reality compared to the dyad ties of individuals not embedded in the clique. From a public policy perspective, individuals holding Simmelian ties share the same policy beliefs and are more likely to engage in collaborative relationships than individuals outside of these ties and cliques (Henry et al., 2011). Simmelian ties also characterize the behavior and relationships of network actors belonging to different subnetworks such as policy subnetworks, managing subnetworks and fiscal subnetworks (Rethemeyer & Hatmaker, 2008). It may be assumed that the behavior of network actors will be contingent on the rules and regulations adopted in the respective subnetworks of cliques constituting a public management network.
Subgroup level concepts

Subgroup level concepts include cohesive subgroups, cohesion, and cliques. As I mentioned earlier, each of these represents an important structural characteristic of a network that can be modeled and linked to specific social, organizational and public management theories.

A subgroup is defined as a network area taking an intermediate position between triads and the whole or the whole network. A cohesive subgroup is a type of subgroup where a large number of network actors have direct, strong, mutual, frequent ties or connections within this particular subgroup (Wasserman & Faust, 1994). The notion of cohesive subgroups is important for studying public policy and public management networks, since cohesive social structures determine the attitudes and behavior of the network actors belonging to these cohesive groups.

Cohesion is a group property showing the attractiveness of group members to each other and their feelings of belonging and motivation to stay together as a group (Prell, 2012). From the social network perspective, cohesion can be defined by the ties connecting network actors together as a group (Moody & White, 2003). As a network structure, a cohesive subgroup has a profound impact on the behavior, attitudes and values of the network actors who belong to it (Prell, 2012). Cohesion can be explained by both affective and relational belonging (Friedkin, 1984; Moody & White, 2003) as well by the presence of Simmelian ties. Simmelian ties have already been described as dyadic relationships that are embedded in triadic relationships. They tend to become stronger and more stable over time (Krackhardt, 1998) and to pressure the network actors in the dyad to conform to the norms of the cliques they belong to (Krackhardt, 1999), thus
increasing the relational belonging. In addition, Simmelian ties force network actors to share similar views on organizational reality (Krackhardt & Kilduff, 2002), which contributes to the cohesion of the group.

Davis (1963, p. 451) defines a clique as “a subset of group members whose average liking for each other is greater than their average liking for the other members [in a group]” Research on cliques can be traced back to the Hawthorn experiment in a bank wiring room, where the researchers identified two groups characterized by a particular special organization and ignorance of occupational specialization (Roethlisberger, Dickson, & Wright, 1939). Belonging to these groups impacted not only voluntary activities such as opening windows, job trading, and candy sharing but also group performance. Workers in group A developed high performance norms, monitored the productivity of each worker in the clique and produced more connections and fewer defects per 100,000 connections than group B.

From a social network perspective, there are several definitions of a clique. Based on the notions of graph theory, a clique is defined as a network structure where “all the actors must be directly connected to each other, and all the actors must have no direct common link to any other actor” (Kilduff & Tsai, 2003, p. 46). Therefore, the clique is a complete subgraph where all network actors are connected to each other. According to Wasserman and Faust (1994), only groups of three or four network actors can be considered to be a clique, which excludes mutual dyads by definition.

Such a strict definition of a clique makes cliques scarce in reality and forces researchers to relax assumptions of mutual ties and to develop more practically oriented definitions of cliques such as n-cliques and k-cores. N-cliques are defined as “groups of
actors who can all reach each other through a maximum of $n$ links” (Kilduff & Tsai, 2003, p. 46). K-cores also relax the traditional restricted definition of a clique. A k-core is a set of network actors where each member of the group is linked to an $n-k$ number of network actors. The value of $k$ has various structural implications for cohesive subgroups in the network. A lower value of $k$ results in a larger subgroup size and better border delineation of the subgroup, meaning that it is easy to see the borders of the subgroup. A higher value of $k$ results in difficulty for new members to join the k-cores (Prell, 2012).

**Global network level concepts**

Global network level concepts include density, centrality, reciprocity, reachability and transitivity. As I mentioned earlier, each of these concepts represents important structural characteristics of a network that can be modeled and linked to the particular social, organizational and public management theories. Moreover, these global network concepts help to distinguish between networks within one organization or compare the networks of different organizations (Kilduff & Tsai, 2003). Since reciprocity was already discussed above, I will focus on density, centrality, reachability, and transitivity.

The density of a network compares the number of existing ties between the network actors to the number of maximally possible ties among these network actors (Wasserman & Faust, 1994). Low density networks are called sparse networks or sparsely connected networks. High density networks, on the other hand, enjoy more connections or ties among network actors and are sometimes called dense or highly connected networks.
Network density $d$ is usually calculated by dividing the actual number of ties existing in the network ($L$) by the total number of possible ties among $n$ number of network actors. The higher this proportion is, the denser the network (see Equation 2.1).

**Equation 2.1: Network density for non-directed networks**

$$d = \frac{L}{n(n-1)/2}$$

The formula for calculating density in a directed network is different from Equation 1 in that one has to calculate all the ties in the denominator (see Equation 2.2).

**Equation 2.2: Network density for directed networks**

$$d = \frac{L}{n(n-1)}$$

Density can be used for comparing only networks of the same size due to the fact that increasing the number of network actors results in an increase of possible ties, and this number is located in the denominator of the formula for calculating network density. For example, if we increase the number of network actors from five to eight, the number of possible ties among these network actors increases from eight to twenty eight.

Similar to other structural characteristics of networks, the interpretation of network density is also contingent on the type of the network and the values of other structural characteristics. One of the most popular uses of density is for measuring the cohesion in the network. A common assumption about the relationship between cohesion and density is that there is a positive correlation between these two concepts. Simply
speaking, the higher the density of a network, the more cohesive is the network. In practice, the relationship between density and cohesiveness is not that straightforward. Even two networks with an identical density can vary in terms of cohesiveness, depending on the centrality of the network (Prell, 2012). If the high interconnectedness of a network is caused by higher centrality, it may also result in a higher cohesiveness of the network even in the case of an identical density. This contradiction in complex relationships between density and cohesiveness was confirmed by Provan & Sebastian (1998) in their study of the networks of mental health agencies. They found that the density of a network had a negative impact on the effectiveness of that network. Contrary to the widespread assumption about the effect of density on network effectiveness, the network with the lowest density of connections yielded the highest effectiveness, whereas the highest density network had the lowest effectiveness.

Nevertheless, the review of public management literature shows that a density of public management and public policy networks sometimes has a positive effect on organizational outcomes such as the adoption of innovations. Agranoff and McGuire’s (1998) study of the structural characteristics of local economic development networks suggested that the density of ties among local economic development departments has a positive correlation with the adoption of economic development policy.

From an evolutionary perspective, it is still not clear how the density of ties impacts the effectiveness of public management networks. Having examined the impact of conflicting institutional pressures on the evolution of one community mental health system, Provan, Isett, & Milward (2004) concluded that collaboration was accompanied by an increased number of ties and a greater strength and multiplexity of the ties over
time. However, the authors of this study make no attempt to establish the relationship between density and network effectiveness over time. This is not surprising considering the fact that density is often treated as the control variable in organizational network research (Kilduff & Tsai, 2003).

Centralization is another structural characteristic widely used in organizational network research. It measures how the network is centralized around one or several network actors (Wasserman & Faust, 1994). A network is considered to be centralized if one or several network actors have very high scores in centrality. Similarly, if all the network actors have approximately the same centrality scores, this results in a decentralized network. Highly centralized networks can be characterized either by a few clustered network actors with high centrality scores or by multiple centers in the networks.

Interpretations of centrality are contingent on the types of networks involved. Centralization in the informal networks of an organization serves as an indicator of the type of organization it is. If the informal networks are highly centralized in an organization, this may suggest that the organization is mechanistic in nature. However, if the organization possesses a number of centers with high levels of centrality, it may point to the organic nature of the organization (Shrader et al., 1989). Burt’s (1992) study of structural holes suggests that the centrality of organizational networks affects the career advancement of high ranking men. Highly centralized networks tend to slow down the career advancement of high-ranking men, compared to those men who are embedded in a low centrality or flat network.
Centrality appears to be a good indicator of the structural development of a public management network. Having compared four community mental health systems, Provan and Milward (1995) suggested that high network centrality is a structural characteristic of an effective network in the stages of execution or implementation. An effective network is characterized by high centralization at the global level, which in turn facilitates the integration of all operational activities. Similarly, Provan, Isett, & Milward’s 2004 study, which examined the impact of conflicting institutional pressures on the evolution of one community mental health system, suggests that the strengthening of collaboration activities is accompanied by increased centralization in a public management network over time.

Reachability can be defined as “the average number of people reached per person over all possible steps” (Kilduff & Tsai, 2003, p. 32). Reachability has great implications for network efficiency especially for communication networks. In high reachability networks, more people can be reached by messages, using the same number of intermediate points, than in low reachability networks. Kilduff and Tsai (2003, p. 32) give an example of reachability in an organization:

If in organization A, each individual contacts friends and friends of friends, and through this two-step process all of the people in the organization are contacted, then A has higher reachability than organization B in which the same two-step process reaches only 50 per cent of the people (p. 32).

Network reachability as a structural characteristic can indicate both how quickly norms and values are diffused as well as the development of conformism in the
organizational network. Compared to low reachability networks, high reachability networks are characterized by a rapid diffusion of norms and values (Prell, 2012).

The transitivity of networks is another structural property of networks at the global network level and is based on the principle “the friends of my friends are my friends.” In other words, if friend A has a friendship tie to friend B, and friend B has a friendship tie to friend C, friend A should be friends with friend C. Transitivity can be measured using a transitivity index, which can be determined by dividing the number of transitive triads by the number of potentially transitive triads (Wasserman & Faust, 1994).

**Equation 2.3: Transitivity Index**

\[
\text{Transitivity}_{\text{index}} = \frac{\text{Transitive triads}}{\text{Potentially transitive triads}}
\]

Transitivity of networks as a structural property at the global level is linked theoretically to balance theory, originally developed as a theory of cognitive consistency (Heider, 1958) for understanding interpersonal structures in a network. The balance of a network is assessed in terms of the relationship between reciprocity and transitivity. If an organizational or interorganizational network exhibits a propensity for low reciprocity accompanied by high transitivity, this network may be hierarchical, with many stars (nodes in the network receiving many ties) who do not reciprocate (Kilduff & Tsai, 2003).

Networks with low transitivity may indicate the presence of fewer cliques in the network. However, the presence of cliques in organizational and interorganizational networks, for instance, interlocking groups organized around different social and
organizational dimensions, promotes unity in the organization, “because for any given person there are fewer others who are socially identical or socially disparate (Davis, 1963, p. 454). In addition, the presence of network subgroups prevent the network from becoming fragmented “by making less probable the development of large, cohesive cliques set totally apart from the rest of the group” (Davis, 1963, p. 454)

Communication networks with high transitivity also can be characterized by information proximity, which can partially explain the emergence of communication networks. For example, if network actor A communicates with network actor B, and network actor B communicates with network actor C, then network actor A is likely to obtain information about and be introduced to network actor C through interactions with network actor B.

Summary

As the literature review in this chapter suggests, a bridge between the process theories of network development and the theories of structural approach is necessary if we are to understand the structural development of public management networks over time. On the one hand, organizational theory provides a number of theories to explain the formation of public management networks, theories such as resource dependency theory (Pfeffer & Salancik, 2003), transaction cost economics (Williamson, 1985, 1986) and the popular set of organizational change theories including life-cycle theories (Kanter, 1994; Larson, 1992; Lowndes & Skelcher, 1998), teleological (Doz, 1996; Ring & van de Ven, 1992, 1994), dialectical (Benson, 1975) and evolutionary theories such as population
ecology (Freeman et al., 1983; Hannan & Freeman, 1977). Process theories, however, provide a limited and fragmented view of the whole process of network formation and ignore structural aspects of network development such as centrality, reciprocity, transitivity, structural holes and cliques. Social-structure-oriented public management scholars, on the other hand, emphasize the structural aspects of public management networks. They attempt to understand the structural characteristics of efficient and effective public management networks at different levels of analysis, such as individual actor level, tie level (dyad and triad levels), subgroup, and whole network or global level. Few of these studies, however, directly investigate the structural characteristics of public management networks at the different stages of network development (Isett & Provan, 2005; Milward et al., 2010; Provan et al., 2009; Provan, Isett, et al., 2004).

The next chapter reveals a theoretical framework for the structural development of public management networks, using a set of structural hypotheses that describe network development over time. These hypotheses are based on the structural aspects of social and interorganizational networks, such as centrality, reciprocity, centrality, transitivity, structural holes, and different types of triads, which were discussed in this chapter. These hypotheses reflect temporal changes in the structural characteristics of public management networks at different levels of network development. More importantly, these structural hypotheses link the structural aspects at the individual actor, dyadic, triadic, and whole network levels to relevant sociological, organization science and public management theories, including some of the theories of network development that were discussed in this chapter.
CHAPTER 3 : THEORETICAL FRAMEWORK OF STRUCTURAL DEVELOPMENT OF PUBLIC MANAGEMENT NETWORKS

This chapter describes the concepts and theories that lay the foundation for a theory of structural development of public management networks. This proposed theory is represented by a set of structural hypotheses describing the development of public management networks over time. These hypotheses were developed using a multitheoretical, multilevel modeling approach (Contractor et al., 2006) that incorporates relevant sociological, organization science and public management theories. This theory will then be tested using the techniques of confirmatory network analysis that include random graph models, such as Markov random graph models (Frank & Strauss, 1986; D. Strauss & Ikeda, 1990) and the p* family of models (Anderson, Wasserman, & Crouch, 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins, Elliott, & Pattison, 2001; Wasserman & Pattison, 1996).

Most of the previously mentioned studies (Isett & Provan, 2005; Milward et al., 2010; Provan et al., 2009; Provan, Isett, et al., 2004) used to understand the development of public management networks suffer from a one level–one theory problem. In other words, these studies are focused on one level of the network and employ one established theory normally derived from sociology or organizational theory. However, public management networks are relational systems that should be studied at the different levels (individual actor, dyadic, triadic and the whole network) via the lens of the various theories that explain the emergence of public management networks.
Having reviewed the literature on communication, organizational and interorganizational networks, Monge and Contractor (2003) spotted nine groups of theories explaining the emergence, development, management and sustainability of organizational networks. They include:

1) Theories of self-interest
2) Theories of mutual interest and collective action
3) Contagion theories
4) Cognitive theories
5) Cognitive consistency theories
6) Exchange and dependency theories
7) Homophily theories
8) Proximity theories
9) Evolutionary and coevolutionary theories

Each of these theories, along with their mechanisms and implications for network development and management are presented in Table 3.1. A researcher studying public management networks in particular cases can employ diverse social theories that use similar theoretical mechanisms to get similar explanations of network development but at completely different levels of social network analysis, i.e., at the individual actor, dyadic, triadic and whole network or global level (Contractor et al., 2006).

Given the limited development of theories about the evolutionary development of public management networks and their scarce empirical base, it is important to remember that “different theoretical mechanisms sometimes offer complementary as well as contradictory explanations at the same level of analysis” (Contractor et al., 2006, p. 683).
### Table 3.1: Social Theories and Theoretical Mechanisms

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<th>Theoretical Mechanisms</th>
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<td><strong>Cognitive consistency theories</strong></td>
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<tr>
<td>Complex adaptive systems</td>
<td>Network density and complexity</td>
</tr>
</tbody>
</table>

However, these theories are an abundant source that can help public management scholars understand the structural development of collaborative and public management networks of all types, as identified by Agranoff (2007).

These social theories along with the statistical advancements of social network analysis allow one to develop testable structural hypotheses about the development of public management networks. A structural hypothesis or “structural signature” is understood here as a pattern of interactions among network members occurring in a network (DeLeon & Varda, 2009; Monge & Contractor, 2003). For instance, let’s hypothesize that during the planning stage, public management networks tend to be less centralized than they are at the implementation stage, so that more voices can be heard in the development of the norms and values that will allow for effective functioning in the future. Then, one can collect data on one particular public management network and test this structural hypothesis by using the techniques of confirmatory network analysis (Wasserman & Robins, 2005). If our structural hypothesis is verified we can conclude that other public management networks of a similar type will bear similar structural characteristics.

Structural hypotheses at the different levels allow for testing the structural tendencies of a network at the different stages of network development. These tendencies reflect the structural properties at different levels that can be linked to sociological, organization science and public management theories, and can be defined by both endogenous and exogenous variables (Contractor et al., 2006). Endogenous variables are those “various relational properties of the focal network itself that influence the probability ties will be present or absent in the same network” (p. 686). They indicate that
a particular network configuration in the observed network has a structural tendency proposed in the structural hypothesis. The traditional examples of specific measures of the endogenous variables at the different levels of analysis include actor structural autonomy (actor level), reciprocation (dyadic level), transitivity (triadic level), cyclicity (triadic level) and network centralization (global level). Exogenous variables are those “various properties outside the focal network that influence the probability ties will be present or absent in the focal network” (Contractor et al., 2006, p. 687). They can include the individual characteristics of the network actor such as gender, socioeconomic status, educational attainment, occupation, organizational affiliation or different network relations such as differential reciprocity (dyadic level), differential transitivity (triadic level), differential cyclicity (triadic level), and differential network centralization (global level). Each of these endogenous or exogenous variables can be linked to one of the nine groups of theories mentioned above that explain the formation, development and maintenance of the network.

3.1 Structural hypotheses of network development at the global level

Structural hypotheses at the global level allow for testing the structural tendencies of a network at different stages of development at the level of the whole network. These tendencies reflect structural properties at the network level that can be linked to sociological, organization science and public management theories. From a social network point of view, these tendencies can be explained using traditional measures of networks such as endogenous variables, including centrality, density, and transitivity.
Centrality. Centrality in public management networks can be interpreted differently depending on the measure of centrality and the theory associated with this measure. The most popular measure of centrality is degree centrality, which can be associated with the degree of power distribution or power structure in policy and public management networks (DeLeon & Varda, 2009). The various stages of network development require different power structure degrees. At the planning stage, public management networks should be characterized by low centrality, so that few network actors hold central positions. From the structural point of view, this indicates a lower ability of particular network actors to have control and influence over the network (DeLeon & Varda, 2009) and a diminished ability to form bridges and fill in structural holes (Burt, 1992; Monge et al., 1998). Centrality also indicates the degree of connectedness. It is expected that the planning stage will have lower scores of network centralization, which suggests that network actors share equal connections and are able to engage in mobilizing activities (Laumann, Knoke, & Kim, 1985; Laumann & Pappi, 1976) and to act in the name of promoting the collective good (Marwell & Oliver, 1993; Marwell, Oliver, & Prahl, 1988). On the other hand, studies by Provan and Milward (1995) and Provan, Isett, & Milward (2004) suggest that the implementation stage is characterized by a high degree of centralization.¹ Based on these studies, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

Hypothesis 1: As public management networks develop over time, they tend to become more centralized.

¹ See chapter 2 (p. 48-49) for a fuller discussion.
Density is another commonly used network property that measures the number of existing ties between the network actors compared to the maximum number of ties possible among these network actors (Wasserman & Faust, 1994). The role of density in the evolution of public management networks is still unclear, although the Provan and Sebastian (1998) study of networks of mental health agencies suggests that an increase in density is negatively associated with public management network effectiveness. But it may be concluded that in the evolution of public management networks the number of ties increases over time. Provan, Isett, & Milward (2004) concluded that collaboration was accompanied by number of ties and strengths of multiplexity of the ties over time. Therefore, it may be reasonably concluded that there will fewer connections at the planning stage than at the implementation stage. As I mentioned in chapter 2, there is a positive correlation between cohesion and density. In other words, the higher the density of a network, the more cohesive is the network. High cohesiveness is important for the normal functioning of a public management network, since high cohesiveness is associated with the presence of rules governing the behavior of network members. Since the rules of operation and interactions are primarily developed in the planning stage, I can conclude that the implementation stage will be characterized by a higher cohesiveness than that of the previous network development stage. Consequently, one can conclude that the density of a public management network will be higher at the implementation stage than at the planning stage, which can be summarized neatly in the following hypothesis for a theoretical framework for understanding the structural development of public management networks over time:
Hypothesis 2: As public management networks develop over time, network density tends to increase.

Transitivity is another useful structural property at the global level that can explain whether the level of hierarchy is linked theoretically to balance theory, originally developed as a theory of cognitive consistency (Heider, 1958). The interpretation of transitivity depends on the type of network. If the network represents friendship relations, then transitivity points at the consistency of choices in selecting friends. If the network is organizational or inter-organizational, then transitivity points at the degree of hierarchy in the organization (Contractor et al., 2006).

According to the balance theory, there is a patterned relationship between reciprocity and transitivity. If an organizational or interorganizational network exhibits a propensity for low reciprocity accompanied by a high transitivity, this network may be hierarchical due to the presence of the stars (Kilduff & Tsai, 2003). It is widely believed that networks are flat and that every network member enjoys the same rights and powers within the domain of that network. However, this is far from the reality that is observed by empirical studies of public management networks. In fact, public management networks are characterized by “a more interesting and ‘hilly’ social terrain that includes aspects of hierarchy” (Rethemeyer & Hatmaker, 2008, p. 636). The initial stages of network development require some sort of hierarchy, where the scalar vector of power is clear, with distinct power differentials between network members. The distribution of power follows the principles of hierarchical and managerial accountability necessary for the processes of planning. During the implementation stage, the power differentials between network members are expected to be leveled off since the power in the network
should be shared by several centers: one center responsible for governing or “managing across” networks and another center responsible for “managing within” networks (Perri, 2006). Therefore, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

**Hypothesis 3a:** As public management networks develop over time, they tend to become less hierarchical (transitivity).

### 3.2 Structural hypotheses at the triadic level

Structural hypotheses at the triadic level are derived theoretically from triadic census analysis and represent the endogenous variables at the triadic level such as transitivity, cyclicity and balance. These hypotheses can be tested by the means of triadic census analysis (Wasserman & Faust, 1994) and later by p* models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996). As I mentioned in chapter 2, triadic census investigates the various triadic network configurations that influence the probability that ties will be present or absent in a network (Contractor et al., 2006). Although social network analysts examine the sixteen components, or isomorphic classes, of triads, the focus here will be on hierarchical, cyclical and fully reciprocated triads in order to develop the structural hypotheses of network development at the triadic level.

**Hierarchical triads.** Hierarchical triads are transitive triads, which are triads with ties from A to B, from B to C and from A to C. As I discussed earlier, the interpretation
of transitivity is contingent on the type of relations in the network (Contractor et al., 2006). The presence of transitive triads in the affective or friendship network (when relations are friendly or sentimental) point to the consistency of relations (Heider, 1958; Holland & Leinhardt, 1975, 1981). In other words, a friend of your friend is supposed to be your friend as well, and we should definitely like the friends of our friends since we already like the latter. When the concept of transitive triads is applied to organizational networks, however, the presence of transitive triads in formal relations or in the transfer of know-how undoubtedly indicates the probability of hierarchy occurring in the network (Contractor et al., 2006). For example, Rank, Robins et al. (2010) assert that “the internal structure of a team is likely to be characterized by strong hierarchical elements” (p. 748). This hierarchy is based on various aspects of teamwork such as division of labor, assigning responsibility, and authority in making decisions (S. P. Robbins & Judge, 2009). Rank, Robins et al. (2010) argue that hierarchical positions found in the organizational network need not be the same as traditional leadership roles. Informal leaders may develop as a result of expert knowledge or by applying the skills of politicking. In this case transitive triads are represented by triads with nodes sending links or ties to one node, and where this node enjoys the position of power. Of particular interest in this case are the hierarchical triads 120C and 210. The graphic representation of triads 120C and 210 can be found in Figure 3.1.

The structural hypothesis about transitive triads in the developmental perspective is related to the degree of hierarchy in the different stages of development. As in the case of transitivity at the global level, a higher degree of hierarchy should be exhibited at the
planning stage than at the implementation stage. This can be explained by the necessities of establishing basic network structure and developing norms and rules.

**Figure 3.1: Hierarchical Triads**

![Hierarchical Triads](http://www.educa.fmf.uni-lj.si/datana/pub/networks/pajek/triade.pdf)


The structural hypothesis about transitive triads “would be supported if there were greater probabilities for graph realizations in which triads of actors in the network exhibited a high degree of transitivity” in the stage of planning (Contractor et al., 2006, p. 689). It can be succinctly written in the following hypothesis:

*Hypothesis 3b: As public management networks develop over time, they tend to become less hierarchical (hierarchical triads).*

*Cyclical triads.* Cyclical triads are triads with ties connecting the network actors in a clockwise order, an example of which is shown in Figure 3.2.

**Figure 3.2: Cyclical triads**

![Cyclical triads](http://www.educa.fmf.uni-lj.si/datana/pub/networks/pajek/triade.pdf)

The presence of cyclical triads can be explained by the theory of generalized exchange (Bearman, 1997; Yamagishi & Cook, 1993). According to the theory of indirect generalized exchange, network members form relations where “each participant provides benefits to an actor in the network who does not return benefits directly to that participant” (Yamagishi & Cook, 1993, p. 237). In other words, network actors form cyclical triads, where network actor A benefits network actor B, network actor B benefits network actor C, and network actor C benefits network actor A, often exchanging resources by means of providing information, receiving information, or giving advice. And these cyclical triads may be developed around multiple relations in multirelational networks (Rank et al., 2010).

The role of indirect generalized exchange at the different stages of network development should be not underestimated. The research on organizational networks shows that the planning stage of network development is usually characterized by direct exchange of resources. This direct exchange implies the development of strategic norms for interactions “among participants that govern the level of mutual contributions and benefits of actors” (Rank et al., 2010, p. 758). The implementation stage, on the contrary, is characterized by indirect generalized exchange where network participants are engaged in the exchange of resources by giving and receiving information, financial support, and many other things. Therefore, the following hypothesis is proposed for the theoretical framework for understanding the structural development of public management networks over time:

*Hypothesis 4: As public management networks develop over time, the flow of resources in the network increases (more cyclical triads tend to occur).*
Balanced triads. As I discussed earlier, balance theory states that people prefer balanced ties in their friendship networks (Heider, 1958). They insist on mutuality and transitivity in their friendship relations, so that their affection is reciprocated and their friends are friends with others. Structurally, balance in a public management network is assessed in terms of the relationship between reciprocity and transitivity (Prell, 2012). The extremes of the combinations of reciprocity and transitivity could be detrimental for the development of the network at some stages. For example, a network with high transitivity and low reciprocity tends to be hierarchical because of the stars, who receive so many asymmetrical ties (Kilduff & Tsai, 2003). At the other extreme, a network with high reciprocity and low transitivity has a propensity to be highly decentralized, with an absence of stars and few cliques. It also has a tendency to be less effective than networks with a lower reciprocity (Provan & Sebastian, 1998). Another example would be the case of a network divided into two subnetworks that are balanced with each other. This balance is achieved by all positive linkages in one subnetwork and all negative linkages in the other subnetwork (Cartwright & Harary, 1956). In short, balance theory seeks a golden middle between reciprocity and transitivity or positive and negative ties. A graphical representation of balanced triads (102 and 300) can be found in Figure 3.3.

![Figure 3.3: Balanced Triads](http://www.educa.fmf.uni-lj.si/datana/pub/networks/pajek/triade.pdf)
From the evolutionary point of view, balance in public management networks should vary depending on the stage of network development. It may be reasonably assumed that the first stage of development, or planning stage, is critical in terms of sustainability and vulnerability of the network. On the one hand, there should be several network centers, responsible for inviting new members into the network and developing norms and rules for the interactions of network actors. Meanwhile, the relationships of the network actors leading the formation of the network should be fully reciprocated so that strategic rules of interactions can be developed (Rank et al., 2010). Later, when the norms and rules of a public management network are developed and several centers that govern and manage the network are developed, the role of balanced triads, especially mutually reciprocated triads, is diminished. Therefore, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

*Hypothesis 5: As public management networks develop over time, they tend to be less balanced and stable (fewer fully reciprocated triads tend to occur).*

### 3.3 Structural hypothesis at the dyadic level

Structural hypotheses at the dyadic level are derived theoretically from the dyadic census analysis and represent the endogenous variables at the dyadic level (reciprocity). These hypotheses can be tested initially by measuring the reciprocity at the global and individual network actor levels. The final testing of the structural hypotheses at the
dyadic level will be conducted by p* models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996)

Reciprocity, another important structural characteristic of a network, signifies the development of trust, mutual support and exchange of resources among network participants. As mentioned earlier, reciprocity is defined by the number of symmetric ties among network actors. The decision to form or join a network, according to social exchange theory, is made by calculating the number and type of resource exchanges (Blau, 1964; Homans, 1950, 1974). As deLeon and Varda (2009) argue, “Each actor in a network must see that he or she will not only benefit by collaboration but also that the overarching goal will be better achieved by working with other stakeholders” (p. 67)

The growth and sustainability of a public management network is conditional on reciprocity in the exchange of resources (Willer & Skvoretz, 1997). Reciprocity is important at the planning stage since network members are engaged in the processes of mobilizing different resources and actors and setting rules, norms and values for the effective future functioning of the network. Or as Rank et al. (2010) state, “The strong preference for the formation of mutual exchange relationships among pairs of actors suggests that within the strategic decision process reciprocity norms have developed among participants that govern the level of mutual contributions and benefits of actors” (p. 758). Subsequently, at the implementation stage, the number of mutual ties will decrease since strategic actions and trust have been developed. Therefore, the following hypothesis is proposed for the theoretical framework for understanding the structural development of public management networks over time:
Hypothesis 6: As public management networks develop over time, reciprocity of ties tends to decrease.

3.4 Structural hypotheses at the individual level

Structural hypotheses at the individual level allow one to test the structural tendencies of a network at different stages of development at the level of the individual network actor. These tendencies reflect the structural properties at the individual level that can be linked to sociological, organization science and public management theories. The structural tendencies can be defined by both endogenous and exogenous variables prescribed by multitheoretical, multilevel modeling (Contractor et al., 2006). Although the endogenous variables at the actor level include different measures of centrality such as degree centrality, closeness, betweenness and prestige, the structural autonomy of the network actor was selected for developing a structural hypothesis instead, since some measures of centrality were indirectly taken into account at the different levels of p* models.

The structural autonomy of a network actor is based on the concept of structural holes (Burt, 1992), which are represented by network actors currently without any connections. As I discussed in chapter 2, these structural holes can be “bridged” by an entrepreneurial network actor who connects the unconnected parts of the network, including subnetworks, cliques and unconnected individuals, and gain great structural advantage by doing so.
The structural autonomy of a network actor also has implications for network development. It can be assumed that network champions target the most popular network actors in the network during the planning stage via the process of activation (Agranoff & McGuire, 2001b), which leads to low structural autonomy and subsequently to a low level of bridging. At this point of network development, in order to pursue the purposes of mobilizing and activation, it would be most beneficial to target network actors with many linkages (Agranoff & McGuire, 2001b). These actors maintain more relations with the various network actors and are capable of mobilizing human, informational, political and material resources when needed. The implementation stage, however, sets new conditions. To ensure access to the untapped resources of various network members it is expedient to forge relations with network actors who have not been connected to anybody in the network at the previous stages rather than to popular “stars” who receive many nominations from other network members. In this way network leaders or network champions can exploit the resources, knowledge and innovations of the network actors who currently have no connections in the network. From the probabilistic point of view, the inclination to forge a tie or connection with currently isolated network actors without ties is less likely at the planning stage. One can then conclude that bridging tends to increase during the process of network development and can be measured by betweenness at the global and two-path network configurations (Snijders, Pattison, Robins, & Handcock, 2006). Therefore, the following hypothesis is proposed for the theoretical framework for understanding the structural development of public management networks over time:
Hypothesis 7: As public management networks develop over time, bridging tends to increase (betweenness and two-path configurations).

Structural hypotheses based on the exogenous variables at the individual actor level allow one to see the effect of the individual characteristics of the network actor such as gender, sector affiliation and interorganizational network experience on the probability of forming a tie at the different stages of network development. The most appropriate theory to be used in this instance is that of homophily (Coleman, 1957; Ibarra, 1992, 1993, 1995, 1997). This theory suggests that network actors tend to form ties with those actors who have similar characteristics. It may be expected that the effect of similarity on the probability of forming a tie may change over time, with the effect of homophily being stronger at some stages of network development than at others. Provided below is the rationale for structural hypotheses based on actor similarity in gender, sector affiliation and interorganizational network experience.

As I discussed in chapter 2, numerous studies suggest that gender significantly predicts how network actors form ties in friendship and communication networks (Brass, 1985; Ibarra, 1992, 1993, 1995, 1997). In short, male networks tend to be detrimental for women and beneficial to men because of their tendency to be homophilous (Ibarra, 1993, 1997), while women are inclined to form differentiated networks (Ibarra, 1992).

Gender similarity as a predictor of forming ties certainly has implications for network development. As a network forms, it can be expected that males have a greater propensity to form ties with males than with females. The dominant position of men in various organizations forces women to form ties with men, who tend to be in the centers
of the network in the initial stages. It has been argued that centrality in the network provides the access to resources necessary for effective performance of the activities in the interorganizational networks (Miller, Lincoln, & Olson, 1981). Therefore, women tend to form more relations with the men positioned in the center of the network (Brass, Galaskiewicz, Greve, & Tsai, 2004). However, the process of implementation changes the pattern of interactions between men and women in terms of homophily. Interorganizational collaboration at this stage is more likely to occur if the network actors share status and power (Emerson, 1962; Ring & van de Ven, 1992). This implies that the power differentials between men and women should be reduced, and neither group should tend toward homophily in collaborative relations. Therefore, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

_Hypothesis 8: As public management networks develop over time, gender similarity has less effect on the propensity to form ties._

Interorganizational network experience has some bearing on the formation of ties, especially in the early stages of network development. Research on organizational and interorganizational networks suggests that interorganizational network experience has some effect on the tendency to form and diversify ties (Ahuja, 2000; Brass et al., 2004; Powell et al., 1996). Powell, Koput, and Smith-Doerr (1996), in their study of biotechnology firms, found a positive relationship between the networking experience and centrality in interorganizational networks. They also report that networking experience allows one to make more diverse connections and enriches the actor’s
knowledge base about his or her industry or area of work. As network actors become more skilled in interorganizational collaboration, they learn more about different ways to interact with diverse stakeholders, with the result that there is a higher probability of forming a tie. Taking these results to the organizational level, this networking experience not only results in greater knowledge of the industry but makes organizations more attractive to other organizations (Ahuja, 2000). Therefore, it is crucial to have more persons with interorganizational network experience in the planning stage since this facilitates the process of activation by reaching those potential and diverse network actors who have the necessary resources for forming the network (Agranoff & McGuire, 2001b). In addition, interorganizational network experience is similar to what Senge (1990) calls the “learning organization,” an organization "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (p.3). This collaborative expertise is vital for a newly formed public management network, where participants have to develop the strategic norms for interactions in the later stages of development.

As a public management network evolves, interorganizational network experience becomes less useful and has less of an effect on the tendency of network members to forge ties. The processes of targeting network actors with generous financial, human, and informational resources are transformed into the processes for finding implementation partners or even for deactivating actors no longer needed at this stage (Agranoff & McGuire, 2001b).
Thus, it can reasonably be expected that individuals with interorganizational network experience will be more inclined to form a tie in the planning stage of network development. It must also be assumed that a similarity in interorganizational network experience also results in the higher propensity to form a tie with other actors who have interorganizational experience. Therefore, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

_Hypothesis 9: As public management networks develop over time, interorganizational network experience has less effect on establishing relations._

Sector similarity is another exogenous variable at the actor level, and it too has an effect on the propensity to form ties within a sector according to the tenets of homophily theory (McPherson, Smith-Lovin, & Cook, 2001). Several studies have found that representatives of organizations from the same sector have a higher propensity to form ties with each other in interorganizational networks (Contractor et al., 2006; Shrestha & Feiock, 2009). Contractor et al. (2006) found that government organizations in the Cooperative Research and Development Agreement (CRADA) network were more likely to form ties with organizations of the same organizational type compared to interactions between government and private organizations. Public and nonprofit organizations are more likely to form relations with each other because of commonly shared attributes such as orientation on the public value, public interest, mission and stakeholders (Moore, 2000).
When networks are formed, sector similarity allows organizations of a similar type to take advantage of commonly shared routines and values for establishing new norms and values during the process of framing (Agranoff & McGuire, 2001b). The implementation stage, however, returns representatives of organizations from the different sectors (public, private and nonprofit) to the modus operandi prescribed by each organizational type. It is expected then that sector identification and the subsequent organizational-type homophily prevail at the planning stage, thus making organizations of a given sector form ties within that sector. However, this conclusion will no longer hold true at the implementation stage. Therefore, the following hypothesis is proposed for the theoretical framework for understanding structural development of public management networks over time:

*Hypothesis 10: As public management networks develop over time, sector similarity has less of an effect on establishing relations in the network.*

**Summary**

This chapter describes the theory of structural development of public management networks represented by a set of ten structural hypotheses describing network development over time. These hypotheses were developed using a multitheoretical, multilevel modeling approach that incorporates relevant sociological, organization science and public management theories in order to understand the structural development of public management networks over time. Each of these structural
hypotheses reflects the changes in the patterns of interactions among network actors (structural tendencies) depending on the stage of network development.

These structural hypotheses will be tested by two types of social network analysis: exploratory network analysis (Nooy, Mrvar, & Batagelj, 2005) and confirmatory network analysis (Contractor et al., 2006). Exploratory network analysis is employed to highlight the structural properties of the Metro School network at each stage of development as well as to test the structural hypotheses at the global, dyadic and individual levels of network on a preliminary basis. The final testing of the structural hypotheses of structural development of public management networks will be performed by using the techniques of confirmatory network analysis, which include triadic census analysis (Wasserman & Faust, 1994) and exponential random graph modeling (ERGM), particularly p* models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996). Triadic census analysis is employed for testing structural hypotheses associated with balanced, transitive and cyclical triads. p* models are used for testing the structural hypotheses associated with such structural aspects of social and organizational networks as degree centrality, betweenness, reciprocity, density and structural autonomy as well as the effect of the individual characteristics of a network actor such as gender, sector affiliation and interorganizational network experience on the probability of establishing a tie at a particular stage of network development.

The next chapter covers the research design and methodology of the study. The logic behind using a mixed-methods design and a longitudinal case study is explicated through the lens of historical research of public management and policy networks. Special attention is paid to the grounded theory approach (Corbin & Strauss, 2008; A. L.
Strauss & Corbin, 1998) employed for collecting and analyzing qualitative data to answer the first research question about the predominant processes of network development at different stages. The collection and analysis of social network data are also thoroughly discussed by explaining the techniques for exploratory network analysis (Nooy et al., 2005) and confirmatory network analysis (Contractor et al., 2006).
CHAPTER 4 : DATA AND METHODOLOGY

A mixed-methods approach was adopted for the development of empirical assessments of the structural configurations of network development over time. The approach was used to evaluate a longitudinal case study that combines quantitative and qualitative data, where different levels of analysis (at the whole network, triadic, dyadic and individual actor levels) are used to develop a global and “thick” picture from a single case, i.e., the proposal and execution of research in the case of the Metro High School network (Yin, 1994). The use of a case study for this kind of research stems from the long-standing tradition of researching public management networks by Agranoff and McGuire (Agranoff, 1991, 2007; Agranoff & McGuire, 2003).

The use of the case study in the present research is appropriate for the several reasons. First, a case study allows researchers to get answers to the “how” questions related to a sequence of events that is not under the control of the researcher (Yin, 1994). Second, the findings of a case study can contribute to theory building about the structural aspects of network development in the field of public management (Eisenhardt, 1989). Third, significant conclusions can be drawn from various interconnected levels of analysis (Pettigrew, 1990). These conclusions can be triangulated with confirmatory social network analysis. The use of confirmatory social network analysis distinguishes this research from previous evolutionary public management network studies that resort to exploratory and descriptive techniques of social network analysis without making any theoretical or conceptual inferences.
4.1 Research Settings and Justification of the Case Selection

The present research is derived from the case of Metro High School, a landmark STEM (Science, Technology, Engineering and Math) High School in Columbus, Ohio. A number of states have launched STEM initiatives as a policy response to the failure of high school systems to prepare students to be successful at work and in higher academic studies, particularly in science and technology and their applications. Reports about the readiness of high school graduates for careers and further study paint a gloomy picture of the future US workforce:

America’s high schools are failing to prepare too many of our students for work and higher education. Just ask business leaders and college presidents, who say they must spend billions of dollars annually to provide their employees and students with the skills and knowledge they should have attained in high school.

(Conklin, Curran, & Gandal, 2005)

This statement, made by the National Educational Summit on High Schools in the United States is well supported by statistics on the achievements of high school students in the United States. Only one in three high school students meets the requirements for Math and English scores according to the standards of their respective states. Only seventy-one percent of US high school students graduate from high school. Finally, only one in three freshman entering colleges and universities in the United States is adequately prepared for standard course work (J. P. Greene, 2005).

The policy debate among politicians, leaders of the business community and educators on the failing high school education in the United States blames the 19th century educational framework for preparing high school students. According to them,
this framework is “aligned to the needs of an agrarian society and uses a curriculum design better suited to a semi-skilled workforce” (Hunter & Agranoff, 2008, p. 3). As a policy response to this wicked public policy problem (Rittel & Webber, 1973), it has been suggested that secondary-level schools should be redesigned, that students should improve their proficiency in science, technology, engineering and mathematics through a STEM education (Morrison, 2007). This response served as a springboard for STEM school initiatives in some US states, including Ohio.

Metro High School was launched concurrently with a special initiative in the state of Ohio to expand the technological infrastructure and to facilitate new high-tech research, business development and job growth across the state. The formation of Metro High School was initiated between 2003 and 2005, and it opened its doors in August 2006. According to the results of a public program evaluation conducted by the research team this school is a vivid example of STEM programming based on public/private partnerships and supported by community learning. The success of this school prompted lawmakers of the state to appropriate new state funding to launch additional STEM schools based on the success of Metro High School.

Metro High School is a truly landmark STEM school, and its philosophy reflects the major attributes of STEM education (Morrison, 2007). It prepares students to be problem solvers who can “frame problems as puzzles and then [be] able to apply understanding and learning to these novel situations (argument and evidence)” (Morrison, 2007, p. 2). Metro High School also teaches students how to be innovators, thinking outside the box, and to engage in independent and creative courses of investigation. Metro High School students are expected to be logical thinkers who can apply the logic
of calculus to understand natural phenomena. The graduates of Metro High school are technologically literate, with their comprehensive knowledge of technology supplemented by the necessary skills for putting technology into practice. From the psychological point of view, graduates of Metro are taught the value of self-reliance so they can “set [their] own agendas, develop and gain self-confidence and work within time specified time frames (Morrison, 2007, p. 2). Finally, Metro High School does not just prepare students for technological careers but gives them the ability to contextualize their technological knowledge and skills historically and culturally.

The Metro High school project is also a suitable case through which to answer the research questions set out in the present dissertation. Metro is both a formal, networked structure and a collection of informal relationships at the individual level that transcend organizational, governmental, and sectoral boundaries. It includes numerous network actors with multiple connections working on collaborative activities. Starting out with a small network of actors responsible for the development of the idea for the networked school, Metro evolved into a larger network that comprises clearly distinct governance and management subnetworks that ensure the maintenance of the network in the tactical and strategic sense.

4.2 Research Timeframe

The timeframe for this study is depicted in Table 4.1. The sequence of time from the evaluation study to the completion of this paper spans five years, from November 2007 to August 2012. Since the present research relies on the data collected during an
evaluation study of Metro High School conducted in the period from November 2007 to May 2008 by a team of researchers including Dr. Robert Agranoff, Professor Emeritus, Michael McGuire, Professor of the School of Public and Environmental Affairs, Indiana University, and the author of this dissertation, the official start of the research sequence is dated November 2007.

**Table 4.1: Research Timetable**

<table>
<thead>
<tr>
<th>Dates</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 2007</td>
<td>Research design of the evaluation study of Metro High School</td>
</tr>
<tr>
<td>December 2007</td>
<td>Design of research tools</td>
</tr>
<tr>
<td>January-February 2008</td>
<td>Conducting interviews and surveys</td>
</tr>
<tr>
<td>January –February 2008</td>
<td>Transcribing interview data</td>
</tr>
<tr>
<td>March 2008-April 2008</td>
<td>Initial coding of the interview data</td>
</tr>
<tr>
<td>May 2009-April 2011</td>
<td>Work on research proposal</td>
</tr>
<tr>
<td>May 2011</td>
<td>Research proposal defense</td>
</tr>
<tr>
<td>June 2011</td>
<td>Writing Chapter 2 on main network governance concepts</td>
</tr>
<tr>
<td>July 2011</td>
<td>Writing Chapter 3 on structural hypotheses</td>
</tr>
<tr>
<td>August 2011</td>
<td>Piloting methodology</td>
</tr>
<tr>
<td>September 2011</td>
<td>Adjust and refine methodology</td>
</tr>
<tr>
<td>September 2011</td>
<td>Writing Chapter 4 on methodology</td>
</tr>
<tr>
<td>November 2011</td>
<td>Secondary and theoretical coding</td>
</tr>
<tr>
<td>December 2011-January 2012</td>
<td>Analyzing social network data</td>
</tr>
<tr>
<td>March 2012</td>
<td>Interpreting the results</td>
</tr>
<tr>
<td>April –May 2012</td>
<td>Writing up results (Chapter 5 &amp; 6)</td>
</tr>
<tr>
<td>June 2012</td>
<td>Writing conclusions and implications (Chapter 7)</td>
</tr>
<tr>
<td>August 2012</td>
<td>Submitting the dissertation draft to my advisor</td>
</tr>
<tr>
<td>September 2012</td>
<td>Presenting the draft to my committee for comments</td>
</tr>
<tr>
<td>September-October 2012</td>
<td>Scheduling, preparing for and taking oral exam</td>
</tr>
<tr>
<td>November 2012</td>
<td>Incorporating changes from orals into the dissertation</td>
</tr>
</tbody>
</table>
A few words should be said about my engagement in the evaluation study Metro High School. I participated in all stages of this public program evaluation project. In the beginning of the research process, I assisted Dr. Agranoff and Dr. McGuire in the development of the social network questionnaire and the interview guide. After the data had been collected, I performed initial and secondary coding as prescribed by the grounded theory approach (Corbin & Strauss, 2008), which was subsequently used in the qualitative part of the present research.

4.3 Interview Data Collection and Analysis

This research relies on the qualitative and quantitative data collected during the evaluation study of Metro High School conducted in 2008 by a team of researchers including Dr. Robert Agranoff, Professor Emeritus, Michael McGuire, Professor of the School of Public and Environmental Affairs, Indiana University, and the author of this dissertation. This study examined the structural and dynamic aspects of the development, maintenance and management of the Metro High School network and networks extending beyond the boundaries of the school into the Columbus and greater Ohio communities. The policy and management networks were of particular interest to this study as they relate to the formation, development and management of Metro High School. From a policy research perspective, this evaluation study allows policy makers and public managers to understand how public/private partnerships in the area of K-12 education are developed, managed and sustained over time.
Metro High School was investigated as a network entity consisting of industry partners, nonprofit organizations, Ohio State University, school districts, teachers, parents and students, and the findings of the study shed light on “the social, political, and cultural connectedness of the school as a whole, as well as to its surrounding environment” (Hunter & Agranoff, 2008, p. 7).

The process of qualitative-data collection and analysis was adapted from the research sequence used in Agranoff’s (2007) research on public management networks:

1. Design by major conceptual and research question development
2. Preliminary case orientation and scanning the terrain by gathering documents and other relevant information
3. Preliminary selection of initial prospective discussants
4. Formatting and outlining of the discussant interactions
5. Preparation of the guide for focused discussions in the field
6. Interviews/guided discussions with initial discussants
7. Identification of other relevant discussants
8. Completing all guided discussions
9. Recording of post-interview impressions and transcript development
10. Organizing information into categories of data—primary, secondary and theoretical coding
11. Development of conceptual findings

The qualitative data are represented by the extended 1-2 hours of focused discussions, or semi-structured interviews, with 28 key representatives of 17 organizations involved in the network school project. These representatives include
CEOs of two major institutions that launched the Metro High School project, individuals who represent the network partnership and who are responsible for steering, and individuals who represent the learning partners involved in curricula development, internships, mentoring, tutoring and other programs. These 28 key representatives were identified by the snowball sampling technique, based on initial discussions with the staff of Metro High School, network champions and network leaders. At first, the staff of Battelle Memorial Institute, PAST Foundation and Metro School were asked to nominate others (Bryman, 2004). When the discussant leaders approached these others, they subsequently asked them to nominate yet more others. The discussion leaders repeated the procedure until the point of theoretical saturation.

Of course, some researchers believe that the snowball sampling method is biased by the original set of network actors that the researcher approaches (Scott, 2001). If the researcher had approached another set of network actors, the results of the sampling could have been different. In this particular study it was an appropriate choice since it allowed researchers to construct a network organized around relations of individuals who formed the “starting point” of the network (Scott, 2001). The initial set of respondents included those who initiated the network and were involved in the strategy making and tactical operations of the network. The final samples of respondents who were interviewed by the discussant leader and surveyed by means of social network analysis are provided in Table 4.2.

The focused discussions with the selected respondents were based on a discussion guide that helped discussants to lead conversations in a more or less common direction. The discussion questions were developed based on the research questions of the
evaluation study. They included questions related to the history of an actor’s involvement in the project at the different stages, as well as specific questions related to management in networks, such as about the development of trust and accountability, making decisions, planning activities, disseminating information, and mobilizing participants to action. The questions were based on collaborative management and network management (Agranoff, 2007; Agranoff & McGuire, 2001b; Huxham & Vangen, 2005; Koppenjan & Klijn, 2004; McGuire & Agranoff, 2007). The list of all discussion guide questions can be found in Appendix A.

**Table 4.2: Samples of focused discussion and survey respondents**

<table>
<thead>
<tr>
<th>Samples and Subsamples</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion respondents</td>
<td>28</td>
</tr>
<tr>
<td>Discussion respondents who filled out Social Network Analysis Questionnaire</td>
<td>25</td>
</tr>
<tr>
<td>Respondents who did not fill out Social Network Analysis Questionnaire completely</td>
<td>1</td>
</tr>
<tr>
<td><strong>Final Sample for Social Network Analysis</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

During the focused discussions, the discussion leader recorded answers to the questions, posing the same questions to each respondent. When the issues had been discussed, each respondent was probed to provide additional information. The respondents’ recorded answers represent unstructured but organizable information, which was later analyzed using the grounded theory approach.

The grounded theory approach can be defined as “a qualitative research method that uses a systematic set of procedures to develop an inductively grounded theory about a phenomenon,” and is designed “to build theory that is faithful to and illuminates the
area under study” (A. L. Strauss & Corbin, 1990, p. 24) Grounded theory ties data collection, analysis and emerging theory closely together:

A researcher does not begin a project with a preconceived theory in mind (unless his or her purpose is to elaborate and extend existing theory). Rather, the researcher begins with an area of study and allows the theory to emerge from the data. Theory derived from the data is more likely to resemble the “reality” than is theory derived by putting together a series of concepts based on the experience or solely through speculation (how one thinks things ought to work.) Grounded theories, because they are drawn from the data, are likely to offer insight, enhance understanding, and provide a meaningful guide to action. (A. L. Strauss & Corbin, 1998, p. 12)

The present study follows such a grounded theory approach, in which the research design is intended to generate rather than validate any prior theory. I rely on the grounded theory approach to set the background for the case as well as to identify stages of development in the evolution of public management networks and what processes are predominant for each stage of development (first research question). Research through grounded theory “does not begin with a preconceived theory in mind. . . . Rather, the researcher begins with an area of study and allows the theory to emerge from the data” (A. L. Strauss & Corbin, 1998, p. 12). Basically, it is a way of looking at the process of development of the Metro network empirically from the perspective of those immersed in the arena. Grounded theory assumes that theory will be derived from the data that were systematically collected and analyzed. Like other qualitative methods, grounded theory
requires in-depth analysis and a reliance on detailed knowledge derived from the data-collection process.

The present research does not use the original grounded theory approach, however, a theory that asks a researcher to start from a blank slate. Instead, it uses the modified grounded theory approach, in which researchers use concepts developed in previous research during the stage of theoretical coding. Rather than requiring a blank slate, the modified grounded theory approach uses a theoretical framework to guide the researcher in the process of scientific investigation. Miles and Huberman (1994) call for qualitative research designs with a distinct conceptual framework, research questions, sampling schemes and elaborated research instruments. Modified grounded theory “puts the qualitative researcher somewhere between designs based on deductive quantitative . . . testing of explicit theoretical propositions and descriptive and causal inference, and thick analysis of nominal data analyzed by inference (Agranoff, 2007, p. 39). Therefore, grounded theory allows one to apply the concepts that help to explain the structural development of public management networks over time. The concepts of network management and network governance help the researcher to conduct theoretical coding as well as build a theory of the structural development of public management networks.

This study is based on qualitative research but complemented by “a positivist systematic case data analysis mode” (Agranoff, 2007, p. 37). This approach has been pioneered in the field of public administration by Agranoff and Radin (1991) and has been applied in a number of studies (Agranoff, 2007; Agranoff & Rinkle, 1986; Radin et al., 1996; Radin & Hawley, 1988). The multistage coding employed in the grounded theory approach reveals profound meanings, a result that clearly differentiates this
approach from other qualitative approaches used in public administration (Williams, 1982).

The qualitative part of this research also follows Eisenhardt’s suggestion (1989) to build theory from case study research. Eisenhardt (1989) says that theory building from case studies begins with defining research questions and developing prior constructs. Then, the researcher carefully selects cases based on theoretical sampling to fill the conceptual gaps in the literature; and this is the intention of the present research. Eisenhardt also suggests that multiple data collection methods and multiple investigators be used in crafting the instruments and protocols, which is also the case in the present study. Agranoff developed and conducted the qualitative data collection and McGuire developed and analyzed the quantitative data collection using a social network survey. The author was involved in all of these phases. The development of instruments and protocols is followed by field work, where data collection and analysis overlap, which “gives the researcher a head start in analysis but, more importantly, allows researchers to take advantage of flexible data collection” (Huberman & Miles, 1981, p. 16)

The analysis of the qualitative data centered on the transcripts of the focused discussions with 28 key representatives of 17 organizations involved in the network school project. The transcripts included information from responses to more than 400 questions. As a means to answer the first research question and further analyze the discussants’ data, NVivo 9.0, a qualitative research software package, was used as an analytical and data sorting tool.

During the analysis of qualitative data, I reviewed the interview data, coding responses in relation to the research questions and organizing the responses according to
the research process outlined in Appendix B, which was also based on the five-step process suggested by (Carney, 1990). First, the text was created based on the focused discussions with the 28 key representatives of the 17 organizations involved in the network school project. Secondly, I performed different coding procedures prescribed by grounded theory, which resulted in the generation of various codes and analytical notes. Thirdly, I identified themes and trends by applying the theoretical or selective coding prescribed by the grounded theory methodology (A. L. Strauss & Corbin, 1998). Fourthly, I tested hypotheses and reduced the large amount of text by analyzing trends. Finally, I outlined the exploratory framework that emerged from theoretical framework by employing the graphic features of modeling in NVivo.

The coding procedures used in analyzing the qualitative data of the focused discussions included a four-step process of coding: initial/primary/open coding, focused coding, axial coding and theoretical coding (Charmaz, 2006; Corbin & Strauss, 2008; A. L. Strauss & Corbin, 1990).

Firstly, the transcripts of the focused discussions or semi-structured interviews with the 28 key representatives of 17 organizations were downloaded to NVivo to construct the initial or primary coding. During the primary coding, I looked at the data and asked the following questions (Charmaz, 2006):

- “What is this data a study of?” (Glaser, 1978, p. 57; Glaser & Strauss, 1967)
- What does the data suggest?
- Which theoretical category do the specific data represent (Glaser, 1978).

Since I used the modified group theory approach, I ignored the rule of initial coding without preconceived notions in mind (Glaser, 1978) and used some of the
concepts and ideas from research in network management, public management networks and social network analysis. As a result, I created the initial codes which were “provisional, comparative and grounded in the data” (Charmaz, 2006, p. 48). They were provisional because I had to stay open to different analytical interpretations. In addition, they could have been reworded at any time to enhance the fit between the data and the theories I was using to make some sense of the data. They were comparative since their presence was checked in all cases under the study.

The three most popular coding practices of grounded theory are word-by-word coding, line-by-line coding and incident-by-incident coding (Charmaz, 2006). Of these three, I chose to use line-by-line coding to perform efficient initial coding. I did not select word-by-word coding due to the fact that I did not have to deal with archived data or Internet data to identify particular images, that is, metaphors at the level of individual words. Incident-by-incident coding was also inappropriate because the qualitative data collected by means of the focused discussions with network actors of the Metro High School project were not based on “[c]oncrete, behavioristic descriptions of people’s mundane actions” (Charmaz, 2006, p. 53). Taking into consideration the first research question in this dissertation, regarding the processes that are predominant for each stage in the evolution of public management networks, the following questions were also asked during the initial coding (Charmaz, 2006, p. 51):

- What process(es) is at issue here? How can I define it?
- How does this process develop?
- How does the research participant(s) act while involved in this process?
- What does the research participant(s) profess to think and feel while involved in this process? What might his or her observed behavior indicate?
- When, why, and how does the process change?
- What are the consequences of the process?

Secondly, I performed secondary coding that included focused and axial coding (Charmaz, 2006). Focused coding involves “using the most significant and/or frequent earlier codes to sift through large amounts data” and “requires decisions about which initial codes make the most analytic sense to categorize your data incisively and completely” (pp. 57-58). Compared to the initial codes generated by word-by-word, line-by-line and incident-by-incident approaches, the focused coding tends to be more conceptual, specialized and directed (Glaser, 1978).

During focused coding, the codes emerge unexpectedly through concentrated and active engagement with the text. Instead of just passively reading the text, the researcher should act upon the data so “[e]vents, interactions, and perspectives come into analytic purview that [the researcher] had not thought of before (Charmaz, 2006, p. 59). The focused codes are developed by comparing data to data, which are subsequently refined by comparing the developed focused codes to other data in order to synthesize and explain the larger chunks of data under study.

Axial coding is the process of transforming initial and focused codes into categories and subcategories that are related to each other by using a “paradigm that involves conditions, context, action/interactional strategies and consequences (A. L. Strauss & Corbin, 1990, p. 96). Specifically, it “relates categories to subcategories, specifies the properties and dimensions of a category, and reassembles the data [a
researcher has fractured during initial coding to give coherence to the emerging analysis” (Charmaz, 2006, p. 60). For Strauss (1987, p. 64), axial coding creates “a dense texture of relationship around the ‘axis’ of the category” (1987, p. 64), which will lead to the development of main categories that can be used in the next step, theoretical coding. Thus, axial coding is intended for sorting, synthesizing and organizing large amounts of qualitative data with subsequent reorganizing of them in new forms (Creswell, 1998).

Axial coding allows one to gather the data back and reassemble it as a whole. Strauss and Corbin (1998) suggest using the questions “when, why, who, how and with what consequences?” (p. 125) to establish the relational links between categories at the conceptual level. These questions helped the author to explain the processes of development of the public management network over time, using the case of Metro High School. Almost every event in the history of Metro was analyzed by using these questions. For example, the planning of Metro High School started from a regular breakfast meeting attended by executives from Battelle and Ohio State University (OSU) in the beginning of 2004, where they discussed a special math and science school. Each side was interested in particular features of some future school. Battelle was interested in advancing math and science education, perhaps creating a specialized high school, whereas OSU wanted to enhance the ability of its future students in the technical fields of the sciences and engineering. This similarity of goals initiated the dialogues, which resulted in further collaboration among the future network champions and leaders.

The axial coding converted the text of the focused discussions into the concepts that specify larger dimensions of the categories by linking them with subcategories. To ensure the scientific approach to the process of linking categories to subcategories,
Strauss and Corbin (1998) suggest a particular organizing scheme to answer the questions of axial coding: conditions, actions/interactions and consequences. Conditions are understood as circumstances or situations that make individuals or groups behave in a particular way. For example, the following statement of one active network participant at the stage of planning reveals a situational factor regarding the formation of the Metro School: “When I heard about the CES grant to start Metro I knocked on X’s door ‘to get a post there.’” In this sentence, the phrase “the CES grant to start Metro” pointed me in the direction of identifying the particular condition. Information about conditions was obtained by answering the why, where and how questions. Actions or interactions refer to the behavioral responses of respondents to a particular event, problem or issue. In the above sentence, hearing about “the CES grant to start Metro” was the condition that resulted in the action of “knocking on X’s door to get a post there.” Information about actions or interactions was obtained by answering the by whom and how questions. Consequences refer to the outcomes of actions or interactions caused by the conditions: “Consequences answer the questions about what happened as a result of those interactions or emotional responses” (Corbin & Strauss, 2008, p. 89).

The final step in coding performed according to grounded theory is theoretical or selective coding, a coding made at the level of abstractions. Theoretical coding is deeply rooted in initial, focused and axial coding and defined as “process of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development” (A. L. Strauss & Corbin, 1990, p. 116). Therefore, theoretical codes integrate the focused codes into a
particular form and help the researcher to tell a coherent story about the findings in a theoretical sense.

At the stage of theoretical coding the researcher also does a case study write-up, which “allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases” (Eisenhardt, 1989, p. 540). These cross-case patterns can be identified in different ways: 1) selecting particular categories or dimensions and searching for within-class similarities coupled with intergroup differences; 2) selecting pairs of cases and developing a list of differences and similarities for each pair; and 3) dividing data by sources and triangulating qualitative data with qualitative data, which is the case in the present dissertation research. In this research study, each respondent was treated as a separate case and the researcher conducted cross-respondent analysis.

As the result of the iterative process of within-case along with the cross-case analysis, overall patterns, themes based on the coding process and relationships between variables became apparent. During this process, I considered and compared explanations while seeking patterns, then established conclusions that were most congruent with the data. This process was a rigorous and consistent mode of examining and comparing information. It should be noted that the NVivo analysis did not replace the coding process used by the author of this dissertation but rather pointed him to quotes, comments, and other types of notes that enabled him to develop and/or verify conclusions that emerged from the interpretive coding.

In the next step, hypotheses or theoretical statements begin to emerge that are supposed to fit existing data in every case. Using replication logic by treating multiple cases like experiments, the researcher either confirms or disconfirms emerged hypotheses
just as in traditional hypothesis testing research situations. The only difference is that disconfirmed hypotheses are not thrown away since they “can often provide an opportunity to refine and extend the theory” (Eisenhardt, 1989, p. 542). A graphic representation of the grounded theory research process combined with systematic case-based theory building within the present study can be found in Figure 4.1.

4.4 Survey Data Collection and Analysis

In addition to the description of processes leading to the development, management and maintenance of Metro network, a social network analysis of the key linkages across the actors during the stages of development of the public management network was performed to examine certain structural tendencies in the network. Certainly, the qualitative data offer an excellent way to determine who was involved in Metro's development and implementation and to what extent the types of linkages existed. However, the data from the questionnaire afforded the ability to determine the structure of the relationships at the different stages of network development.

The selection of social network analysis as a method for answering research questions set out in the beginning of this study is predicated on the assumptions of social network analysis. Firstly, the analysis of the pattern and structure of the relationship in public management is more essential for understanding the behavior of the network actors or participants than their individual characteristics such as gender, political affiliation, their position in the organizational hierarchy, etc. (Knoke & Yang, 2008).
Figure 4.1: Research Sequence for Qualitative Part (Grounded Theory)

1. Data Collection and Production
- Creating Discussion Guide on Metro School study
- Identify actors
- Conduct discussions
- Create field notes
- Creating text discussant by discussant
- Memo writing
- Importing Data into NVIVO
- Primary Coding
- Secondary Coding
- Fieldnotes and text preparation (Charmaz, 2006)

2. Cross-Respondent Pattern
- Selecting categories; Similarities and differences
- Pairs of respondents
- Triangulating data
- Pre-concepts identified
- Building theory from cases Eisenhardt, (1989)

3. Data Analysis
- Trends, themes and relationship clustering
- Data reduction for Confirmation
- Delineation of deep structure/ exploratory framework
- Conceptualization (Charmaz, 2006, Carnet 1990)

4. Data Display
- Time ordered matrix
- Event flow network
- Role by time matrix
- Presentation/explanation (Miles and Huberman, 1994)

Results of Basic measures of Social Network Analysis

Secondly, “social networks affect perceptions, beliefs, and actions through a variety of structural mechanisms that are socially constructed by relations among entities” (p. 5). Social analysis allows for the identification of the theoretical mechanisms for understanding the evolution of public management networks at the different stages of development. Finally, social analysis is based on the assumption that social networks are not carved in stone and tend to change over time and that structural relationships are dynamic in their nature.

Having looked at these assumptions, one can certainly say that social network analysis is a perfect fit for answering the second, third and fourth research questions of this project. Particularly, it identifies the structural configurations of public management networks at the different stages of network development at different levels of the network (actor level, dyadic level, triadic level and global level). It can measure the effect of individual characteristics of the network actors such as gender, sector differences and interorganizational network experience on the structural configurations of public management networks over time. Finally, it can reveal the effect of social capital, measured by previously established relationships, on the structural development of the public management network over time.

The quantitative data were gathered by means of 2-page questionnaires, where a matrix of collaborator identity and key activity in the network was determined. Each respondent was asked to identify up to 16 individuals who were important in terms of involvement with Metro High School and to describe the types of network activities/engagement respondents were involved in. The questionnaires were administered immediately after the one and a half hour discussions with Dr. Agranoff to
avoid response biases (Groves et al., 2004). Using a 6-point Likert scale ranging from Never (0) to Daily (5), respondents indicated the frequency with which they worked with the named individuals on the following activities: providing information, receiving information, providing financial resources, receiving financial resources, joint planning, and involvement in project and policy negotiations. A copy of the social network survey can be found in Appendix B.

The original sample for the quantitative part consisted of 25 focused-discussion participants who completed the social network questionnaires and an additional 29 survey respondents such as Metro High School administrators, teachers and other individuals involved in the operations of the Metro School project. Since this study was a longitudinal case study, I had to analyze participant data at the different stages of network development. Therefore, the data of the additional 29 survey respondents who completed the social network analysis questionnaire but who were not interviewed were omitted from the final sample. To construct the social network data, I resorted to using the data from the 28 focused discussions and the 25 social network analysis questionnaires completed by the discussants after the focused discussions.

For the quantitative data production process, I constructed the directed network of 28 actors from the 17 organizations involved in the Metro High School project at three time points: 1) pre-project stage, 2) the planning stage and 3) the implementation stage. These three analytical phases of network development were constructed based on the results of coding the qualitative data and selected items from the survey. The pre-project stage is the stage before Metro High School was constructed and is represented by the relation defined as personal knowledge of a person involved in Metro High School. This
relation was identified based on the survey question, “How long have you known this person?” If the respondent indicated knowing a particular person for more than three years, the response was coded as “1,” otherwise, the response was coded as “0.” The planning stage represents another relation—working with people at the planning stage—and includes various activities such as initial meetings, curriculum development, learning program development, finding and allocating resources, etc. The directed network at the planning stage was constructed based on the coding of the interview questions relevant to the development of the network, using the qualitative software package NVivo. The directed network during the implementation stage was constructed in a fashion similar to that of the directed network at the planning stage. However, the qualitative data for the construction of the implementation stage network were triangulated with the survey data due to the fact that some respondents of the focused discussions did not fill out the social network analysis questionnaire or their questionnaires contained incomplete information. The results of these triangulations have shown that the implementation network constructed based on the responses of respondents is very similar to the implementation matrix constructed based on the answers from the social analysis survey questionnaires. This, in fact, validates the use of the focused discussion transcripts for constructing the directed network for the planning stage and this similarity of responses between the focused discussions and surveys serve as a reliability test. In addition, the research of Wright and Pescosolido (2002) suggests that we can rely on the interviews as a means for collecting longitudinal network data. Having used semi-structured interviews to study the personal networks of people with mental problems, they came to the conclusion that

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“people with mental problems can provide descriptions of the changes in their social networks that are reliable and relatively free from recall bias” (p. 113).

To test the static hypotheses of the structural theory of public management network development I analyzed the pre-planning, planning and implementation networks using exploratory and confirmatory social network analysis (Contractor et al., 2006). A graphic representation of the exploratory and confirmatory social network analysis process in this proposed study can be found in Figure 4.2.

As part of this exploratory network analysis, I computed and interpreted commonly used measures of public management networks at the global level such as centrality, density, reciprocation, transitivity and homophily (Wasserman & Faust, 1994), using UCINET (Borgatti, Everett, & Freeman, 2002) to test some of the hypotheses described in Chapter 3 about structural hypotheses regarding the development of public management network over time. In addition, the pre-project, planning and implementation networks were visualized using the network visualization software called NETDRAW, which comes as a part of the UCINET package. The visual representations allowed for differentiating between different subnetworks such as governance and management subnetworks as well as for looking at the different structures emerging in the networks over time. In addition, this tool can provide a ballpark estimation of homophily based on the individual characteristics of network actors. For example, the visualizations of the networks of Metro High School at the pre-project, planning and implementation stages showed the gender segregation among the network participants without looking at the homophily indices. It showed that the men tend to be central actors
**Figure 4.2: Research Sequence for Quantitative Part of the study (Social Network Analysis)**

1. **Data Collection and Production**
   - Creating social network survey Questionnaire
   - Snow ball sampling Collecting Data
   - Creating matrices for different stages of network development
   - Importing Data into UCINET, PNET and RSiena
   - Developing and collecting data for Social Network Analysis
     Wasserman & Faust (1994)

2. **Data Analysis**
   - Computing and interpreting basic social network measures using UCINET
     Wasserman & Faust (1994)
   - Confirmatory Social Network Analysis with triadic census analysis
     (Wasserman & Faust (1994) using PAJEK)
   - Confirmatory Social Network Analysis with P* models using PNET
     (Wasserman and Pattison 1999)
   - Multi-Theoretical Multilevel Modelling
     (Contractor, Wasserman, & Faust, 2006)

3. **Data Display**
   - Visualization of networks by network stages using NETDRAW and PAJEK
     Wasserman & Faust (1994), Nooy, Mrvar & Batagelj 2005
   - Tables with Basic SNA measures
     Wasserman & Faust (1994)
   - Triadic Census tables by network stages
     Knoke & Yang 2008
   - P* modeling tables by network stages
     Contractor, Faust & Wasserman (2006)

*Literature based concepts*
- Huxham and Vangen (2005)
- Social Network Analysis
  Wasserman & Faust (1994)
- 1. Data Collection and Production
  - Creating social network survey Questionnaire
  - Snow ball sampling Collecting Data
  - Creating matrices for different stages of network development
  - Importing Data into UCINET, PNET and RSiena
  - Developing and collecting data for Social Network Analysis
    Wasserman & Faust (1994)
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    Wasserman & Faust (1994)
  - Triadic Census tables by network stages
    Knoke & Yang 2008
  - P* modeling tables by network stages
    Contractor, Faust & Wasserman (2006)
in the networks at the pre-project and planning stages and tend to reciprocate relationships more with men than with women.

To answer most of the research questions, I used confirmatory network analysis based on multitheoretical multilevel modeling (Contractor et al., 2006). Particularly, I used triadic census analysis (Wasserman & Faust, 1994) to test structural hypotheses at the different stages of network development and exponential random graph modeling (ERGM) using a multitheoretical multilevel approach at different stages of the network development.

Triadic census analysis refers to sixteen triadic network configurations that influence the probability that ties will be present or absent in the network (Contractor et al., 2006). This analytical tool was developed by Holland and Leinhardt (1970) to identify the configurations of triads in social networks. Wasserman and Faust (1994) argue that there is considerably more that we can learn from a count of triads, known as a triadic census, because the analysis does not condense the original data as much as a dyad census: a triadic census analysis has sixteen components rather than just the three components that can be found in a dyadic census. As discussed in Chapter 2, on main network and governance concepts, the sixteen triads range from completely null triads to completely mutual triads. The graphic depiction all sixteen types of triads can be found in Figure 4.3.

Researchers analyzing the sixteen components, or isomorphic classes, in a triadic census use a labeling scheme that highlights the dyadic states contained within the triad. For example, a triad could theoretically contain no linkages among the three actors, such that there would be zero mutual (connected in both directions) dyads in the triad, zero
asymmetric (connected in one direction) dyads in the triad, and three null (no connection) dyads in the triad.

**Figure 4.3: Sixteen types of triads**


This triad is labeled as having a 003 triad class, with the three characters signifying mutual, asymmetric, and null dyadic states. On the other extreme, a triad could consist of complete mutuality (three mutual dyads) with no asymmetric or null dyads. This triad class is labeled as a 300. Since there are a total of sixteen such classes, the labeling scheme can include labels such as 201 (two mutual dyads in the triad, zero asymmetric dyads in the triad, and one null dyad in the triad) or 210 (two mutual dyads in the triad, one asymmetric dyad in the triad, and zero null dyads in the triad). Thus, the triadic
census is an expedient way to reduce an entire sociomatrix to a smaller set of sixteen summary statistics. The triadic census analysis was performed using Pajek software (Nooy et al., 2005).

Exponential random graph modeling (ERGM) employs statistical models based on random graph models such as Markov random graph models (Frank & Strauss, 1986; D. Strauss & Ikeda, 1990) and the p* family of models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996). These models allow researchers to test the structural tendencies of the observed network and make “conclusions both about global network properties (the probability of the graph or, more precisely, the nature of the graph distribution) and about the probability of network ties, given properties of their surrounding network (a local property)” (Contractor et al., 2006, p. 686).

Exponential random graph models view the social network as a dependent variable and aim to explain the structure of the network (Prell, 2012). From a statistical point of view, exponential random graph models seek to identify the probability distribution for a particular network and determine if an observed network is different significantly by chance. Although traditionally used in statistics, normal distribution is of no use for this process. Therefore, exponential random graph models employ an exponential family of distributions and an exponential function of linear parameters. Particularly, they are based on the Hammersley-Clifford theorem (Besag, 1974), which postulates that a probability model for $Y$ is only contingent in the cliques of dependence graph $D$. This characterizes $\Pr(Y=y)$ in the form of an exponential family of distributions (Wasserman & Robins, 2005) as shown in Equation 4.1.
Equation 4.1: Hammersley-Clifford theorem

\[
Pr(Y = y) = \left( \frac{1}{k} \right) \exp \left( \sum_{A \subseteq N_D} \lambda_A \prod_{(i,j) \in A} y_{ij} \right)
\]

where:

- \(Y\) - a random network
- \(y\) – an observed network
- \(i\) – a network actor sending a tie
- \(j\) – a network actor receiving a tie
- \(k = \sum_A \exp \left\{ \sum_{A \subseteq N_D} \lambda_A \prod_{(i,j) \in A} y_{ij} \right\}\) - normalizing quantity
- \(D\) – dependency graph for \(Y\), which is the sum of all subsets \(A\) of nodes \(D\)
- \(\prod_{(i,j) \in A} y_{ij}\) - sufficient statistic which corresponds to the parameter \(\lambda_A\)
- \(\lambda_A = 0\) is defined by the situation when the subgraph created by the nodes in \(A\) is not a clique of \(D\)

The Hammersley-Clifford theorem (Besag, 1974) was used in a study by Frank and Strauss (1986) to describe Markov dependence. Markov dependence can be defined as an assumption postulating how ties are dependent on one another. For example, a tie between network actor A and network B depends on any and every possible tie between A and B. To further this assumption, if network actor A and network actor B share a connection or tie with network actor C, then the relation between network actor A and network actor B is contingent on the relationships each of them have with network actor C. The above-described dependence was also extended to the actor attributes and called Markov attribute assumption (Robins, Snijders, Wang, Handcock, & Pattison, 2007).
example, the link between network actor A and network actor B can be contingent on the
gender of the network actors, meaning that gender similarity influences the probability of
a link being established between two actors, an idea that is supported by the theory of

Exponential random graph models and p* models in particular explain the
network structure by looking at lower-level network configurations that are independent
of each other in accordance with the Markov independence assumption. A network
configuration can be described as “a set of nodes (usually small) and a subset of ties
among them” (Robins, Snijders, et al., 2007, p. 194). Three basic types of network
configurations can be distinguished: edge, 2-star and triangle. Each of the basic network
configurations are graphically depicted in Figure 8. An edge can be defined as a mutual
tie between two network actors. A 2-star is a network configuration consisting of three
network actors where one network actor is connected to two other network actors. A
triangle is a set of three network actors connected by mutual ties. It is important to note
that the network configurations depicted in Figure 4.4 are derived from nondirected
networks.

Figure 4.4: Network configurations for nondirected networks
Equation 4.2 provides an example of a Markov random graph model for nondirected networks that estimates parameters for the effect of edges, 2-stars, 3-stars and triangles.

**Equation 4.2: Example of a Markov random graph model for nondirected networks**

\[
\Pr(Y = y) = \frac{1}{k} \exp \{\theta L(y) + \sigma_2 S_2(y) + \sigma_3 S_3(y) + \tau T(y)\}
\]

where:

- \(Y\) = a random network where each possible tie can be regarded as a random variable
- \(y\) = the observed network, where each tie is the observed tie
- \(\theta\) = density or edge parameter
- \(L(y)\) = the number of edges in the observed network \(y\)
- \(\sigma_k\) = the parameter associated with \(k\)-star effects
- \(S_k(y)\) = the number of \(k\)-stars in the observed network \(y\)
- \(\tau\) = the parameter for triangles
- \(T(y)\) = the number of triangles in the observed network \(y\)
- \(k\) = a normalizing quantity ensuring a proper probability distribution in the model

Parameters in a Markov random graph model for a nondirected network can estimate the effects of edges, \(k\)-stars, \(k\)-paths and triangles. For example, “a large and positive estimate for \(\tau\) suggests that, given the observed number of edges and stars, networks with more triangles are more likely; that is, that there is a strong transitivity effect in the network” (Robins, Snijders, et al., 2007, p. 195). It is worthwhile noting that setting the star and triangle effects to zero will always result in a nonzero effect for the edge parameter \(\theta\) in the observed network \(y\).
Network configurations can be derived from directed networks as well. While the important network configurations for nondirected networks or graphs are the quantity of edges, k-stars and triangles (Frank & Strauss, 1986), directed network configurations have a more extensive list of possible configurations. They include: reciprocity, cyclic triads, transitive triads, outdegrees an indegrees. The attribute effects include the homophily effect (when network actors select each other based on similarity) and the ego-covariate effect (when network actors representing the public sector have more connections than representatives from the private sector). Some of the network configurations for directed and nondirected networks are shown in Figure 4.5.

**Figure 4.5: Possible network configurations for directed and nondirected networks**

Extensive application of the Frank and Strauss (1986) model in empirical and simulation studies indicates that this model tends to give results that are a poor fit to the real data and that it does not explain particular structural characteristics (Prell, 2012; Robins, Snijders, et al., 2007). These problems have been remedied in the p* model developed by Wasserman and Pattison (1996). The formula for the p* model is shown in Equation 4.3.

**Equation 4.3: p* models**

\[
\text{Prob}(Y = y) = \left(\frac{1}{k}\right) \exp \sum_{A} \eta_{A} g_{A}(y)
\]

where:

*Y* = a random network where each possible tie can be regarded as a random variable

*y* = the observed network, where each tie is an observed tie

*A* = the summation for all configurations

\(\eta_{A}\) = the parameter corresponding to a given configuration A (the number of triangles, for example)

\(g_{A}(y)\) = the network statistic corresponding to a given configuration A (the number of triangles, for example)

k = a normalizing quantity ensuring a proper probability distribution in the model


The advantage of the p* model over the Frank and Strauss model (1986) is the inclusion of various network statistics based not only on Markov dependence assumption (edges, k-stars and triangles) but on other network statistics known as higher order configurations. Higher order configurations in general include alternating k-stars,
alternating k-triangles and alternating independent two-paths (Snijders et al., 2006). More specific examples of higher order configurations include 2-triangle, 3-triangle, 4-triangle, two-independent two paths, three-independent two paths, four-independent two paths, directed 2-triangle, directed 3-triangle and directed 4-triangle. A graphic representation of higher order configurations in undirected and directed networks can be found in Figures 4.6 and Figure 4.7.

The inclusion of higher order configurations was possible by extending the Markov dependence assumption, which is restrictive in its nature. This extended assumption is called partial conditional independence (Pattison & Robins, 2002; Snijders et al., 2006). Under this assumption, two possible ties \(y_{il}\) and \(y_{kj}\) can be partial conditionally dependent if they share a common network actor and if they are included in a four-cycle. Higher order configurations provide more explanations for an observed structure, especially the transitive aspects of a network (Snijders et al., 2006).

Parameter estimation in the p* model is based on Markov chain Monte Carlo likelihood simulations (Gilks, Richardson, & Spiegelhalter, 1996) and is used to select the values of parameters that provide the highest probability of a given effect (transitivity) in the observed network. Particularly, p* models employ the Robbins-Monro algorithm (H. Robbins & Monro, 1951) or Geyer-Thompson algorithm (Geyer & Thompson, 1992) for parameter estimation.

During this process, computer programs like Siena (Boer et al., 2006) or PNet (Wang, Robins, & Pattison, 2009) simulate graphs using the initial parameter values, and these values are adjusted later based on a comparison of the distribution of the graphs with the graph of the observed network. Having estimated the parameter values, one has
to look at a parameter value for a particular network statistic like reciprocity or 2-stars to
determine the statistical significance. For example, if the parameter value for a number of
transitive triads is equal to zero, the observed frequency of transitive triads is considered
to be determined by chance given that all other parameters are not equal to zero in the
given model. For another example, if the number of transitive triads is high in the
observed network and the network parameter for transitive triads is highly positive and
statistically significant at a 0.05 level, then the given network contains more transitive
triads than expected by chance.

**Figure 4.6: Higher order network configurations for undirected networks**

![Diagram of higher order network configurations](image)
Figure 4.7: Higher order network configurations for directed networks

Alt-in-star (AinS)

Alt-in-1-out-star (AinloutS)

Alt-in-alt-out-star (AinAoutS)

Alt-out-star (AoutS)

1-in-alt-out-star

AT-T

AT-D

A2P-T

AT-C

AT-U

A2P-U

A2P-D


The process of using p* models has already been described in the literature on social networks (Robins, Pattison, Kalish, & Lusher, 2007; Robins, Snijders, et al., 2007). Prell (2012) outlined the six steps of p* modeling, depicted in Figure 4.8.
Step 1: Making assumptions about the network and the network ties (Prell, 2012). p* models assume a fixed set of network actors that can be connected by relationships on a random basis. For example, the social network data represents a fixed network of 28 network actors who are the key representatives of 17 organizations involved in the Metro network project. If two network actors are connected with a tie, this tie is considered to be a random variable (Robins, Pattison, et al., 2007). Therefore, the presence or absence of network ties is also random. Speaking statistically, there can be a random variable $Y_{ij}$ representing a network tie between network actor $i$ and $j$ belonging to set $N$ of $n$ network actors.
actors. If a network tie between network actor $i$ and $j$ is present, then $Y_{ij} = 1$. If a network tie between network actor $i$ and $j$ is absent, then $Y_{ij} = 0$. Subsequently, $y_{ij}$ is defined as the observed value of the variable $Y_{ij}$ for $Y$ matrix of all random variables, with $y$ being the matrix for all observed ties (Prell, 2012).

Step 2: Making assumptions about the contingencies among network variables (Prell, 2012). Traditionally, inferential statistics is based on the premise that each observation in a sample is supposed to be independent of the others. The network data by its nature contradicts this assumption since ties in a network are conditionally dependent on each other by having and not having a network actor in common (Markov dependence). Or two ties can be incorporated in a four-cycle or share a common network actor, which characterizes partial conditional dependency (Prell, 2012). Robins, Pattison, et al. (2007, p. 177) provide an excellent example illustrating this assumption:

For instance, ties may be assumed to be independent of each other, that is, people form social connections independently of their other social ties. This is not usually a very realistic assumption. In the example of the school classroom with reciprocity processes in place, if student A likes student B, then student B will quite probably like student A implying some form of dyadic dependence. Ties may also depend on node-level attributes, with for instance possible homophily effects in the classroom. (p. 177-178)

Therefore, all ties are considered to be Markov dependent (Frank & Strauss, 1986) or partially conditionally dependent (Pattison & Robins, 2002; Snijders et al., 2006), and the model is based on the probability of distribution graphs with certain dependency assumptions (Prell, 2012).
Step 3: Making assumptions about the homogeneity of parameters (Prell, 2012). The assumption of a network configuration’s homogeneity (Frank & Strauss, 1986) is based on the idea that all network actors in the observed network are inclined to have the same behavior for a given network configuration. A network configuration is defined here as “a small subset of possible network ties,” which represent “structural characteristics of interest” (Robins, Pattison, et al., 2007, p. 178). Using network configurations such as reciprocity or transitivity can decrease the number of parameters because of the assumption of the homogeneity of the network configurations. For example, in an interorganizational network such as Metro High School, all 28 key participants are assumed to have the same tendency towards transitivity, so one can use only one parameter for the network statistic for transitivity. The assumption of the homogeneity of the network configurations is violated, however, by exogenous variables or nodal attributes such as gender, age, networking experience, and sector of an organization.

Step 4: Specifying your model. (Prell, 2012) recommends starting by specifying your model from the traditional network statistics of Markov graphs, including reciprocity, k-stars and triangles, which tend to perform well for small networks. Having added lower-order network configurations, one should add higher order network specifications such as 2-triangle, 3-triangle, 4-triangle, two-independent two-paths, three-independent two-paths, four-independent two-paths, directed 2-triangle, directed 3-triangle and directed 4-triangle for nondirected networks. Needless to say, all network configurations should correspond to the hypotheses set out in the theoretical framework. In our particular case, almost all the structural hypotheses about the development of the
network structure were translated into a particular network configuration, whether a lower order configuration or higher order configuration.

Step 5: Estimating parameter values. During this step, parameters are estimated from the data using the Markov chain Monte Carlo process described earlier. The software programs usually use either Robbins-Monro (Robbins & Monro, 1951) or Geyer-Thompson algorithms (Geyer & Thompson, 1992) for parameter estimation. The present study uses a computer software called PNet (Wang et al., 2009) for estimating parameters. Later, the obtained parameter estimates are compared with the graph statistics extracted from the simulated networks to check how well they fit (Agranoff, 1991; Robins, 2009).

Step 6: Interpreting your model. The researcher is supposed to look at the parameter values and the corresponding standard error for the modeled network statistics. Conventionally, a ratio of parameter to standard deviation over 1.96 suggests the statistical significance of the results (Prell, 2012).

4.5 Measurement

Table 4.3 provides a summary of measures for all structural hypotheses used in exploratory social network analysis and confirmatory network analysis. The structural variables used to test the hypotheses by exploratory network analysis include traditional measures used in social network analysis such as density, reciprocity, indegree centrality, betweenness and transitivity.
<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1: As public management networks develop over time, they tend to become more centralized.</td>
<td>Degree centrality &lt;br&gt; Alt-in-star (p* models) &lt;br&gt; Alt-out-star (p* models) &lt;br&gt; Ain1out-star (p* models) &lt;br&gt; AinAout-star (p* models)</td>
</tr>
<tr>
<td>Hypothesis 2: As public management networks develop over time, density of networks tends to increase</td>
<td>Density &lt;br&gt; Arc (p* models)</td>
</tr>
<tr>
<td>Hypothesis 3: As public management networks develop over time, they tend to become less hierarchical (transitivity 3a and transitive triads 3b)</td>
<td>Transitivity &lt;br&gt; Transitive triads (triadic census) &lt;br&gt; Transitive triads and AT-T path closure (p* models)</td>
</tr>
<tr>
<td>Hypothesis 4: As public management networks develop over time, the flow of resources in the network increases (more cyclical triads tend to occur)</td>
<td>Cyclical triads (triadic census) &lt;br&gt; Cyclical triads (p* stars)</td>
</tr>
<tr>
<td>Hypothesis 5: As public management networks develop over time, they tend to be less balanced and stable (fewer fully reciprocated triads tend to occur)</td>
<td>Balanced triads (triadic census) &lt;br&gt; Balanced triads (p* stars)</td>
</tr>
<tr>
<td>Hypothesis 6: As public management networks develop over time, reciprocity of ties tends to decrease</td>
<td>Reciprocity (dyad based) &lt;br&gt; Reciprocity (p* stars)</td>
</tr>
<tr>
<td>Hypothesis 7: As public management networks develop over time, bridging tends to increase (betweenness and two-path configurations)</td>
<td>Betweenness &lt;br&gt; 2-path (p* stars) &lt;br&gt; AT-T (path closure)</td>
</tr>
<tr>
<td>Hypothesis 8: As public management networks develop over time, gender similarity has less effect on the propensity to form ties.</td>
<td>Density by gender &lt;br&gt; Interaction of actors with exogenous variables or attributes (p* stars) &lt;br&gt; Sending a link by an actor with attributes (p* stars) &lt;br&gt; Receiving a link by an actor with attributes (p* stars)</td>
</tr>
<tr>
<td>Hypothesis 9: As public management networks develop over time, interorganizational network experience has less effect on establishing relations</td>
<td>Density by interorganizational network experience &lt;br&gt; Interaction of actors with exogenous variables or attributes (p* stars) &lt;br&gt; Sending a link by an actor with attributes (p* stars) &lt;br&gt; Receiving a link by an actor with attributes (p* stars)</td>
</tr>
<tr>
<td>Hypothesis 10: As public management networks develop over time, sector similarity has less effect on establishing relations in the network</td>
<td>Density by sector &lt;br&gt; Interaction of actors with exogenous variables or attributes (p* stars) &lt;br&gt; Sending a link by an actor with attributes (p* stars) &lt;br&gt; Receiving a link by an actor with attributes (p* stars)</td>
</tr>
</tbody>
</table>
Degree centrality is measured by the number of ties held by one particular node (Wasserman & Faust, 1994). Since the present data relates to a directed network, degree centrality is measured by the outdegree and indegree centrality. The outdegree centrality is a measure of the number of ties coming out of a node or a network actor. The indegree centrality is a measure of the number of ties coming to a node or a network actor.

The density of a network measures the number of existing ties between the network actors compared to the number of maximally possible ties among these network actors (Wasserman & Faust, 1994).

Network density $d$ is usually calculated by dividing the actual number of ties existing ($L$) in the network and the total number of possible ties among $n$ number of network actors. Since the present study examines directed networks, the formula for calculating density is as follows: $d = L / ((n(n-1)/2))$.

Transitivity at the global level is measured by a transitivity index that can be found by dividing the number of transitive triads by the number of potentially transitive triads (Wasserman & Faust, 1994).

Cyclical triads are those triads with ties connecting the network actors in a clockwise order, where a network actor A has a tie to network actor B, network actor B sends a tie to network actor C and finally network actor C has a tie to network actor A, thus finishing the cycle (Wasserman & Faust, 1994). The measure of cyclical triads can be obtained from software called Pajek (Batagelj & Mrvar, 1996) and be used as a network configuration for p* modeling in PNet (Wang et al., 2009).

Balanced triads are those triads consisting of three complete mutual dyads with no asymmetric or null dyads. This triad class is labeled a 300 in the triadic census analysis.
The measure of balanced triads can be obtained from Pajek (Batagelj & Mrvar, 1996) and be used as a network configuration for \( p^* \) modeling in PNet (Wang et al., 2009).

Reciprocity or mutuality relates to the number of symmetric ties among the network actors and can be found by dividing the number of symmetric ties by the number of potentially symmetric ties (Wasserman & Pattison, 1996).

Betweenness centrality measures the degree to which a network actor is directly connected to those nodes in the network that happen not to be connected directly to each other (Wasserman & Faust, 1994). Betweenness measures the degree to which one particular node serves as a bridging point between different network actors. Betweenness centrality is measured by the actor betweenness index, which is found by dividing the number of geodesics linking actors i and j that pass through node k by the number of all geodesics linking actors i and j.

Two-path, sometimes called mixed 2-star, is a network configuration derived from standard Markov random models that consists of three nodes connected by arcs so that actor i sends a tie to actor j and actor j, in turn, sends a tie to actor k (Wasserman & Pattison, 1996). A graphic representation of a two-path can be found in Figure 4.9.

Alternative Transitive Triads (AT-T), or path closures, represents a two-path with the elements of traditional transitivity where network actors i tend to select network actors j who tend to select actors k, who in turn are selected by network i actors, thus creating a structural hole for closing (Robins, Pattison, & Wang, 2008). In addition, AT-T is used for measuring transitivity in high-density networks due to the incorporation of transitive triads in this structural configuration.
Centrality measures in confirmatory network analysis are represented by the following higher order configurations: alternating k-in-star or Alt-in-star (A-in-S), alternating k-out-star Alt-out-star (A-out-S), Ain1out-star and AinAout-star. These higher order configurations of directed networks are designed to control for the indegree and outdegree distribution. Alt-in-star (A-in-S) describes in particular the configuration where many network actors each send a tie to one network actor, which is sometimes referred to as popularity spread (Robins et al., 2008). This serves as an excellent measure for in-stars—network actors with many incoming ties or connections and few outgoing ties or connections to other network members. Similarly, Alt-out-star (A-out-S) is a higher order configuration depicting a situation where one network actor sends ties to other network members, which is sometimes referred to as activity spread.

Table 4.4 shows general information about the explanatory or exogenous variables: gender, organizational affiliation and previous interorganizational network experience. In terms of gender, respondents are represented by 10 males and 18 females. This should not be surprising since this network consists mostly of representatives from K-12 institutions and higher-education establishments.
Table 4.4: Description of the explanatory variables

<table>
<thead>
<tr>
<th>Gender</th>
<th>Absolute value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>10</td>
<td>35.7</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
<td>64.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interorganizational network experience</th>
<th>Absolute value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19</td>
<td>67.8</td>
</tr>
<tr>
<td>No</td>
<td>9</td>
<td>32.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organizational Affiliation</th>
<th>Absolute value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>10</td>
<td>35.7</td>
</tr>
<tr>
<td>Foundation/Enterprise/Partnership</td>
<td>6</td>
<td>21.4</td>
</tr>
<tr>
<td>Network High School</td>
<td>3</td>
<td>10.7</td>
</tr>
<tr>
<td>School Districts</td>
<td>5</td>
<td>17.8</td>
</tr>
<tr>
<td>Learning Centers</td>
<td>4</td>
<td>14.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sector Affiliation</th>
<th>Absolute value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector</td>
<td>19</td>
<td>67.9</td>
</tr>
<tr>
<td>Private Sector</td>
<td>9</td>
<td>32.1</td>
</tr>
</tbody>
</table>

Previous interorganizational network experience was coded as a binary variable based on the interview question, “Have you ever been involved in working with an organization like NHS before?” According to the descriptive statistics, 19 responses to these questions were coded as positive and 9 responses were coded as negative.

Sector affiliation was determined by the author of the study based on the available information. Nonprofit organizations were coded as private or public based on the type of funding they receive. As a result, the sector composition of respondents included nineteen
public organizations and nine private organizations. In addition, Table 4 shows the
distribution of network actors by organizational affiliation, which was defined based on
their relationship to Metro High School.

Summary

This chapter covers data description and methodology. It provides the specific
explanation and reasoning for why a longitudinal case study design was selected. Each
step of the data collection, data production and analysis was explained in detail. The four-
step process of coding, including initial/primary/open coding, focused coding, axial
coding and theoretical coding, was highlighted in this dissertation due to the fact that
grounded theory was applied to trace the dynamics of public management with an
emphasis on the processes predominant at each stage of network evolution or
development. Special attention was devoted to the explanation of stochastic and dynamic
network modeling due to the fact that these methods are new analytical tools for public
administration researchers. At the end of this chapter, I provided and justified the
measurement of the concepts used in the exploratory social network analysis as well as
stochastic and dynamic network models. Based on these descriptions, the process of data
collection and analysis will be more transparent and allow the reader to make a judgment
about the rigorousness of the methodology. The next chapter describes the analytical
results of the qualitative part of the study.
CHAPTER 5 : EVOLUTION OF PUBLIC MANAGEMENT NETWORKS: CASE OF METRO HIGH SCHOOL

The fifth chapter discusses the case study of the Metro High School network. Using grounded theory, I identify those processes that are predominant for each stage of development in the evolution of public management networks. The case also provides vital background information for subsequent explanations or interpretations of the results of stochastic network modeling in the sixth chapter.

5.1 Reasons for establishing Metro High School

Metro High School, a landmark STEM (Science, Technology, Engineering and Math) High School in Columbus, Ohio, is one of the many STEM initiatives that were launched by different states as a policy response to the failure of high school systems to prepare students to be successful at work and in further academic studies, particularly in science and technology and their applications. According to the statistics, only one out of three high school students meet the requirements in Math and English according to the standards of their respective states. And only one in three freshman entering colleges and universities in the United States is adequately prepared for the standard course work (Greene, 2005). One policy response to this “wicked” public policy problem (Rittel & Webber, 1973), was to suggest that secondary-level schools be redesigned in order to improve science, technology, engineering and mathematics (STEM) education (Morrison,
2007). This response served as a springboard for STEM school initiatives in some US states, including Ohio.

Metro High School was launched concurrently with a special initiative of the state of Ohio to expand the technological infrastructure and to facilitate new high-tech research, business development and job growth across the state. The formation of Metro High School was initiated between 2003 and 2005, and it opened its doors in August, 2006. When it opened, it had a freshman class of 99 students, and there were approximately 100 students admitted each year after that. It was founded by and currently operates within an extensive network of governmental and nongovernmental partners. Metro’s curriculum includes 18 subject-related credits in accordance with the requirements for high school graduation in the state of Ohio as well as credits taken by the students at Ohio State University. The success of the school prompted the lawmakers of the state to appropriate new state funding to launch additional STEM schools based on the success of Metro High School.

5.2 Major actors of Metro High School Network

The Metro High School network is both a formal, networked structure and a collection of informal relationships at the individual level that transcend organizational, governmental, and sectoral boundaries. Metro is a unique example of a networked organization that combines both public and private partnership. The Metro High School project unites different partners including the Metropolitan Partnership Group, the Educational Council, school districts, the Ohio Department of Education, Ohio State
University, Battelle Memorial Institute, PAST Foundation, Knowledge Works and other learning sites. Below is a brief description of each of the major participants of Metro High School network.

Metro Partnership Group

The Metro Partnership Group (MPG) is composed of seven members and is responsible for advising on programs at Metro High School, professional development of staff, and other issues such as funding. In addition, MPG acts as a liaison with the community and determines the policy of community relations.

The Metro Partnership Group defines its roles as: (1) maintaining the partnership; (2) overseeing and supporting the Metro curriculum, programs, and operations; and (3) transmitting knowledge to a larger community. The Metro Partnership Group is a unique public-private partnership that breaks the established stereotype of operating based on each organization’s standard operating procedures, rules and policies. MPG is a real example of collaborative governance in action. All decisions are made based on extensive inquiries, fruitful discussions and finally conversion of opinions. According to one member of the Metro Partnership Group, divided votes are not observed since, “We always discuss, never vote.” From an organizational point of view, the Metro Partnership Group can be considered a postmodern bureaucracy, which has a traditional hierarchy tuned for horizontal interactions with different stakeholders.
Educational Council

The Educational Council is considered the official policy body of Metro and is the co-governing and sponsoring body of the Metro School project. It includes sixteen superintendents. The Educational Council came into existence because of “suburban concern over the City of Columbus annexing and preempting massive amounts of assessed valuation from suburban school districts” (Hunter & Agranoff, 2008, p. 78). Educational Council funding is based on the dues paid by each district, which are proportional to the number of students living in each district (Educational_Council, 2008).

Formed in 1986, this nonprofit organization “foster[s] cross-district programming and improve[s] education through a confederation of 16 public school districts in Franklin County” and “provide[s] a forum for district leaders to gather together to discuss issues in education and develop and implement innovative educational programs” (Educational_Council, 2008). The Educational Council is responsible for several joint education-related programs that cut across districts including After School Counts, KIDSConnect, Family Intervention, Mosaic, Cross District Innovation and Metro. As the governing and sponsoring body for Metro High School, the Educational Council is responsible for developing the different policies as well as approving the curriculum of the school. When some districts refuse to fill all their student slots at Metro, the Education Council is sometimes engaged in swapping the contested seats’ districts.

The Educational Council is also nested within the Metro Partnership Group since two superintendents and the president of the Educational Council are members of the Metro Partnership Group. These members serve as a bridge between the Educational
Council and the Metro Partnership Group in terms of transmitting decisions between these two governing structures.

The Educational Council holds monthly meetings, presided over by its chief executive officer and attended by the principal of Metro High School. As in the case of the Metro Partnership Group, the Educational Council applies the principles of open discussion and voting while reviewing the meeting agenda.

School Districts

Administrators and counselors from 16 school districts are responsible for promoting Metro within their respective schools and for dealing with prospective students. Superintendents and school boards associated with Metro provide access for the communities of the Greater Columbus area and communicate the feelings and opinions about Metro to the governing and administrative core of Metro. Some boards have expressed hostility at the cost of tuition transferred for individual students. Others have argued that the math and science instruction at the home school is superior, so that there is no need to send students to Metro. Other boards, however, are highly supportive. For example, some districts “bought in” the slots of other districts because of the recommendations of their superintendents.

The Ohio Department of Education

The Ohio Department of Education (ODE) has been involved with the Metro School project at all stages of the network development from formation to implementation. It deals with such issues as curriculum development, field-based
learning, school regulations and requirements for graduating. ODE is responsible for reviewing different curriculum ideas, including the integration of language arts, science project experiences, and field-based learning. Most of the interactions between Metro High School and the Ohio Department of Education are to ensure that the school is compliant with Ohio Education Standards, which in turn allows Metro students to take classes at Ohio State University and graduates of Metro to enroll at OSU to continue their higher education (Hunter & Agranoff, 2008).

The Ohio State University

Within OSU, the core deans spent a lot of time at the beginning informing and educating their faculties and the administration. Respondents described OSU as "college-centric" in terms of university governance. Therefore, the OSU president’s administration took a collaborative initiative to promote the idea of Metro. There was a lot of apprehension, as most universities had divested themselves of laboratory schools over four decades ago. The deans of the involved OSU colleges immediately reacted positively to the idea of STEM education, however, and thought especially about how better prepared future students would be in math and science specializations.

Learning Partners/Centers

A large part of the Metro education experience takes place in the field at various learning centers, such as the Wexner Center for the Arts, Columbus Museum of Art, Battelle and OSU laboratories, the Mayor's Office, SWACO, COSI, and others. The work
of PAST is key in organizing much of the on-the-ground learning in the field, integrating STEM pedagogy outside of the classroom, and contributing contacts. A lot of preparation work including workshops, meetings and discussions was done to ensure the effective learning connections between Metro staff and Learning Partners. That mutual understanding between Learning Partners and Metro would not exist without the central role of the Metro principal who served as the nerve center connecting different Learning Partners and learning sites.

The results of interviews have shown that neither Metro faculty and staff nor the Learning Partners understood the operational restrictions. Learning Partners/centers do not always have a clear idea about the restrictions imposed on Metro, such as mixed admission, the Ohio Graduate Test, and other requirements. Similarly, the staff and teaching personnel of the Metro High School did not grasp the restrictions of the earning partners’ operations. Therefore, Metro staff and the Learning Partners had to sit down and develop a collaboration platform for working more efficiently and effectively (Hunter & Agranoff, 2008)

The Learning Partners and Metro are connected in different ways. The principal of Metro school is directly engaged with representatives from the PAST foundation on issues related to programming, grants and organizing field learning. The PAST foundation is directly engaged with teachers and the graduate interns from Ohio State University in designing learning experiences and research agendas related to the field learning experiences.
5.3 Network processes at the planning stage

Analysis of guided discussions with 28 key representatives from 17 organizations involved in the network school project shows that the processes that predominantly lead to the formation and development of networks include identification of key individuals, identification of key resources, mobilizing activities, setting norms, rules and values, and developing and building trust, which is consistent with the model of network behaviors developed by Agranoff and McGuire (2001b). The identification of key individuals and key resources corresponds to the behavior called activation. Mobilization activities correspond to the mobilization behaviors, whereas setting norms, rules and values can be equated to the network behavior called framing. As for developing and building trust, it can be affiliated with both framing and synthesizing. The summary of network processes at the planning stage were broken down chronologically in the event listing (Miles & Huberman, 1994) that can be found in Table 5.1.

**Identification of key individuals**

Throughout the whole planning period for the Metro High School project one can see the vital need for identifying the key individuals necessary for the development and maintenance of the Metro network. Metro High School would not have happened in the first place but for those who provided vision, guidance and leadership as well as necessary financial, informational and human resources and expertise.

Selecting key partners and acquiring critical financial resources dominated the early days of the development of the Metro network. As is shown in Figure 5.1, the selection of key individuals began in the beginning of 2004 when top managers from
<table>
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<th>Year</th>
<th>Identification of key individuals</th>
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<td>1989-2003</td>
<td>• Affiliation of KnowledgeWorks with CES&lt;br&gt;• Interest of OSU in math and science education&lt;br&gt;• The Business Roundtable pushing a STEM concept</td>
<td>• Gates Foundation grant on designing 28 small schools</td>
<td>• Unofficial search for space and sponsors&lt;br&gt;• OSU explores possibilities of a STEM school&lt;br&gt;• President sells the idea of STEM schools to the OSU Board of Trustees</td>
<td>• 10 principles of Coalition of Essential Schools&lt;br&gt;• Starting small, staying small&lt;br&gt;• Public and private partnership&lt;br&gt;• General-access school</td>
<td>• Institutional linkages of Battelle Memorial Institute and Ohio State University</td>
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<td>2003-2004</td>
<td>• A special talk of OSU and Battelle CEOs to start a STEM school&lt;br&gt;• Attendance of meeting at Tacoma by representatives of Battelle, COSI, OSU, Knowledge Works (KW)&lt;br&gt;• Engagement of the executive director of the Educational Council (EC)&lt;br&gt;• Recruitment of school principal</td>
<td>• A three-year, $1.2 million building lease of facilities by OSU&lt;br&gt;• Battelle assigns a project manager for Metro project</td>
<td>• President of Ohio State University persuades the deans of colleges&lt;br&gt;• CEO of Battelle and OSU President mobilizes support of their organizations&lt;br&gt;• Tacoma meeting&lt;br&gt;• MOU between Battelle, OSU, EC and Columbus schools</td>
<td>• Triangles of issues&lt;br&gt;• STEM education&lt;br&gt;• 10 principles of Coalition of Essential Schools&lt;br&gt;• Defining basic principles and basic operating parameters of Metro High School at Tacoma meeting</td>
<td>• Common vision and shared values&lt;br&gt;• Personal and social relations at Tacoma meeting&lt;br&gt;• Regular meetings and discussions&lt;br&gt;• Settling disagreements&lt;br&gt;• Establishing a greater value</td>
</tr>
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| 2004-2005 | • Engagement of OSU deans  
• Assigning Battelle and OSU architect for rebuilding space  
• Engagement of PR firm for campaign by Battelle | • KW provides $1 million for initial expenses and tuition  
• PAST Foundation provides $194,000 in program development services | • Consultations with mayor  
• Public announcement about Metro opening  
• PR campaign about Metro | • Development of the Metro school philosophy | • Regular meetings and discussions  
• Settling disagreements  
• Establishing a greater value |
| --- | --- | --- | --- | --- | --- |
| Winter-Summer 2006 | • Consultation with architects | • Battelle provides $600,000 for first two years  
• Tax-based, public school, student support from state  
• Time commitment of MPG  
• Lining up key players in MPG | • PR campaign about Metro | • Development of the Metro school philosophy | • Regular meetings and discussions |
Battelle Memorial Institute and Ohio State University (OSU) “talked at a regular breakfast meeting and discussed a special math and science school” (from the interview with one of the network founders). Each of these breakfast participants pursued their own interests. The interest of Battelle Corporation was in promoting math and science education and hoping eventually to establish a specialized math and science high school. The representatives of Ohio State University were interested in getting better-prepared prospective students who’d had a STEM education. The similarity of their goals served as a springboard for the discussions about the future school. Step by step, these discussions become more heated and extensive and eventually brought about the conceptual platform for Metro High School.

More network actors started joining this new school initiative, including representatives from KnowledgeWorks Foundation, a foundation promoting school innovations. KnowledgeWorks had already helped to organize Ohio high schools into 58 units under the umbrella of the Ohio High School Transformation Initiative with the support of the Gates Foundation. This school innovation project has had long-standing relations with the Coalition of Essential Schools (CES) at the national level. These connections eventually facilitated the procurement of a $200,000 grant from the Gates Foundation and Coalition of Essential Schools to open a small school in the area of Columbus.

In addition, the Ohio Business Roundtable supported the concept of STEM, which helped to facilitate discussions around the idea of establishing the Metro School. Through these discussions, the principles of STEM and the Coalition of Essential Schools (CES) were linked together to lay the conceptual foundation.
Figure 5.1: Identification of key individuals in Metro network in the planning stage

Notes: bubbles represent actors, rectangles represent events
The gift of a $200,000 grant from the Gates Foundation and Coalition of Essential Schools allowed for the recruitment of two former teachers, a Columbus schools student, and a science expert as well as the engagement of the executive director of the Educational Council in the project. Thus, the small network starting growing and attracting more network actors.

The Educational Council, which engages in cooperative programs, offered needed space and gap costs. It was not the first collaborative involvement of the Educational Council, as it has already supported and sponsored various Learning Partnerships and centers such as the Christopher Program, which facilitates personalized learning, as well as Safe School Audit, After School Counts, the Safe and Drug Free School Consortium and many others. By means of an understanding among the partners, the Educational Council became the official body for Metro policy, although their decisions were, and remain, subject to a host of prior partner discussions and prior agreements.

Metro High School was initiated and promoted by two network champions, the president of Ohio State University and the CEO of Battelle Memorial Institute. Also in early and continuing support were three deans from Ohio State University, the director of the Center of Science and Industry (COSI), two representatives from KnowledgeWorks, the vice president of Battelle, the superintendent of Columbus Schools and the CEO of the Educational Council, each of whom became a future partner of Metro High School. All but one of them went to Tacoma, Washington to attend a conference of the Coalition of Essential Schools. They ultimately agreed to put their organizations behind the school with the understanding that it would involve public-private partnerships and other
collaborative working relationships. Thus, the initial Metro network emerged from an idea for a small high school almost two years before the school opened.

Selecting the key individuals for building Metro High School was crucial at the early periods of the planning stage. Discussants have noted some difficulty in recruiting additional players after the main core of network champions and funders was formed. The network started growing more quickly as representatives of Battelle, OSU, KnowledgeWorks, the Educational Council, and COSI met in Tacoma. During this meeting the previous working and personal relationships were strengthened while new professional and personal relationships were formed.

In sum, the identification of key individuals necessary for the development and maintenance of a public management network was the initial network process that activated the development of Metro school. Two network champions, the president of Ohio State University and the vice president of Battelle, brought together potential network actors who might contribute the vital resources for the formation of the Metro School network.

**Identification of key resources**

Metro High School would not exist but for the acquired necessary financial, informational and human resources and expertise. These resources had to be identified, assessed and utilized to create the program and achieve project goals. Figure 5.2 shows the actor-event network for the identification of key resources in a graphical form.

The $200,000 grant from the Gates Foundation and Coalition of Essential Schools to open a small school in the area of Columbus was obtained by KnowledgeWorks,
which heralded the process of identifying the key resources. This single grant, from which the Metro High School project originated, subsequently attracted financial commitments from future partners and activated human resources with different areas of expertise.

**Figure 5.2: Identification of key resources in Metro network**

![Diagram of key resources in Metro network]

Notes: bubbles represent actors, rectangles represent events

The search for critical resources continued in the quest for a very inexpensive or completely free space for the future STEM school, which was critical for the whole enterprise. The attempts to convince Columbus City Schools to be a provider of space for the new school failed due to the refusal of their district. The Center of Science and
Industry (COSI), a nonprofit science museum was also approached with a request for leasing space for this new school. However, this too was unsuccessful due to the high costs of space renovation. Finally, Ohio State University, which was interested in locating the STEM school in the core Columbus area donated a campus building for the Metro school.

Metro High School came into existence thanks to the commitments made by the network founding partners in the form of money, various types of expertise, goods and services. Battelle, for example, initially contributed and pledged $600,000 per year to ensure the existence of the Metro School during its first years. In addition, Battelle provided key staff for the implementation of the Metro idea, including a project coordinator, who was stationed at the school, as well as staff who worked with the graduate students who tutored Metro students and conducted learning experiences. Battelle also engaged its public relations firm, which had long-standing relations with Battelle, for the project to conduct an awareness campaign about Metro School. OSU contributed a three-year, $1.2 million lease of facilities for conducting classes and also provided OSU architects to help with lab design and with remodeling the leased space.

The sixteen school districts in Columbus, Ohio, developed a special arrangement for exchanging funds and services. Due to the special status of Metro School as a program, not a real school, all Metro students belong to the “home schools,” from which they were drafted by lottery. According to the policies negotiated by the Educational Council, each school district enjoys a particular number of student seats for each new intake of students into Metro School. Upon graduation, Metro students are entitled to two diplomas—one from Metro and one from their home school.
The school districts participating in the Metro School project also negotiated that tuition is transferred from the tax-based, public school in an amount equivalent to student support from the state. According to this scheme,

[each school from the 16 participating districts sent with their Metro enrolled student a per capita payment of $5840 per year. This support represented $578,160 (99 students) in the first year, and $1.19 million (204 students) in the second year. . . . This transferred tuition does not cover all costs associated with the students. Each Home School absorbs the administrative costs of transacting credits, academic counseling, as well as the costs associated with Metro students who opt to participate in Home School after-school activities, such as band and sports. Metro absorbs approximately $90,000 for Special Education costs and $90,000 for subsidized school lunches. (Hunter & Agranoff, 2008, p. 50)

As for other network founders, KnowledgeWorks provided $1 million dollars over three years for various things such as start-up, technical assistance, and providing college tuition grants. Another contribution made by KnowledgeWorks was for the provision of teacher mentorship during the academic year. The PAST Foundation also provided $194,000 in program development services during the first academic year of Metro.

The Metro Partnership Group’s involvement in the planning of Metro High School is another example of the identification of key resources. First of all, a time commitment was crucial for the whole process of planning. A lot of time was spent for the appraisal, design and development of the Metro concept, and participants of MPG spent a great deal of time of building relationships with each other. Secondly, participants
did not have stereotyped knowledge about each other so they could tap each other’s resources without prejudice. As one participant said: “We did not know one another before. There was not a lot of baggage. We were brought together over the issue.”

Thirdly, because participants of MPG had no legal authority, they had to line up the key players and then engage in trust building to keep them on board. Fourth, the Metro Partnership Group ensured that all the concerns and fears of stakeholders were heard. For example, the Coalition of Essential Schools was concerned that they were not getting the proper credit. To deal with this concern, the Metro Partnership Group emphasized the 10 principles of the Coalition of Essential Schools. One MPG member admitted in the interview “we might have pushed the limits, but we did acknowledge them.” Finally, from the very beginning of the project, MPG members were not rigid in their thinking or decision making, which allowed for smooth and sustainable dynamics as the project evolved.

The case of Metro High School clearly demonstrates that the identification of key resources is the predominant activity in the planning stage. The Metro High School project emerged from a single grant, which initiated the process of discussing the idea and inviting human resources to the Tacoma meeting. Agranoff and McGuire (2001b) would argue that the key resources that were activated during the initial stages of planning Metro High School were human resources, in the form of the expertise necessary for conducting the feasibility study, as well as a variety of financial sources.
Mobilizing activities

Mobilizing activities are vital for the survival of public management networks, especially at the early stages of development when the networks are particularly fragile and in urgent need of internal and external support. According to Mandell (Mandell, 1988, p. 33), mobilization “requires a view of the strategic whole and an ability to develop and achieve a set of common objectives based on this whole” (Mandell, 1988, p. 33). Mobilizing activities include mobilizing organizations (Mossberger & Hale, 1999, September), mobilizing coalitions (Kickert & Koppenjan, 1997), mobilizing communities, reaching agreement about the role of an organization and its scope of work within the network’s functioning (Benson, 1975), and finally, ensuring the support of representatives’ organizations (Agranoff & McGuire, 2001b).

Organizations participating in the network formation cannot be mobilized without network champions who have a clear vision and passion that can infect others and bring participants to the common goal. Even though leadership in public management networks is different “from leading large, centralized, hierarchically arranged institutions in which the leader guides followers who are employees of their organization” (Van Slyke & Alexander, 2006, p. 364), the role of leaders in the formation of public management networks cannot be underestimated. First of all, network leaders must clearly articulate the vision, bringing different partners to the table and conveying the vision to the key persons who have the necessary resources to be tapped. Secondly, network leaders must gain and maintain support from supervisors in order to successfully work outside of the traditional, agency boundaries (Silvia, 2011, p. 69). Finally, they must coordinate the relationships among key individuals and broker “organizational and individual
contributions, and deploy[ ] energies in accord with some strategic plan” (Agranoff & McGuire, 2001b, p. 314).

Figure 5.3 clearly shows that the Metro High School project would not have happened without the leadership and passion of two network champions: the CEO of Battelle Memorial Institute and the president of Ohio State University. These two network champions did not hammer out the details of the various agreements themselves. Instead, they mobilized the support of their respective organizations, monitored progress and provided overall leadership during the early stages of the Metro High School project.

**Figure 5.3: Mobilizing activities in Metro network (actor-event-state network)**

Notes: bubbles represent actors, rectangles represent events, pentagon represents a state
The mission of the two leaders was not easy one. First of all, they had to sell the idea of a STEM school and its principles to internal and external audiences. The president of Ohio State University had to persuade the deans of OSU’s colleges (internal audience) and the board of trustees (external audience) to become involved in the project and to make the corresponding investments. As a result, the College of Math and Sciences, the College of Biological Sciences and the College of Education and Human Ecology became involved in the Metro High School project as investors. As for Battelle’s CEO, his role was to mobilize the corporate engagement of Battelle and its stakeholders and to establish a working relationship with OSU. Secondly, both network leaders acted as mobilizers of those communities represented by various nonprofit organizations, business associations, Ohio state legislators and state agencies. According to one of the discussants, the “two presidents were the ‘ice cutters’ who helped to move the obstacles out of the way.” It is necessary to note that neither network champion was engaged in the technical aspects of collaboration among the key partners in the Metro High School project. Instead, they guided the process wherein different parties contributed to the project and honored their commitments.

The success of any public management network depends on the degree to which the general public and the community as a whole approves the raison d’être of the network. Having met in Tacoma and having held discussions with the mayor of Columbus, key partners decided to go public. As one network actor said in the guided discussion: “It was important that we make a public declaration to do it and involve a diverse set of civic leaders.” The network champions and other key partners were convinced that “it was a ‘stake in the ground’ promise” that was necessary for moving
forward. Therefore, in the beginning of 2005, it was publicly announced that Metro High School would open its doors and welcome 100 students from 16 Franklin County school districts in August 2006.

Some work with the public was done by a PR firm, a long-standing partner of Battelle Memorial Institute. A representative of this PR firm helped to develop messages and materials about the STEM concept, so that the general public would be able to grasp and appreciate the value and the importance of STEM education. In addition, this person anticipated the questions the public would have and made necessary contacts to ensure the effectiveness of the PR campaign. The campaign, which involved publishing news stories via press releases, did have an effect. Afterward, network founders were joined by other organizations from the public and private sectors, for example the Ohio Department of Education and the Ohio Business Roundtable.

Ensuring the legitimacy of a network by gaining public support is a mobilizing activity that is especially crucial at the early stages of public management network development. Network legitimacy is often taken for granted by practitioners in the public sector, while scholars of public management raise questions and concerns (Agranoff & McGuire, 1999; Agranoff & McGuire, 2001b; Klijn & Koppenjan, 2000; Provan & Kenis, 2008; Silvia, 2011). Many authors agree that “there is no built-in or automatic, legally-based legitimacy” (Hunter & Agranoff, 2008, p. 53) when it comes to the formation of public management networks. In this case, legitimacy was achieved by going public, making announcements about the partnership of the major network founders—Battelle, the Educational Council and Ohio State University—and finally by the signing of the Memorandum of Understanding by OSU and other key partners.
Ohio State University was also successful in promoting the Metro school through inclusive town hall meetings that were open to all. The Metro School was positioned as having a "small school with a big footprint" design (Hunter & Agranoff, 2008, p. 54) that had the potential to involve a significant proportion of Metro’s students in the college experience by allowing them to take classes at Ohio State University.

Based on the above-mentioned information, one can clearly see the importance of mobilizing activities such as mobilizing organizations, coalitions, the community and the general public, and of getting internal and external support from those organizations.

**Setting norms, rules and values**

Setting norms, rules and values is essential for the development of any public management network and, according to the model of network behaviors (Agranoff & McGuire, 2001b) is a framing activity.

As shown in Figure 5.4, it was during the meeting in Tacoma that the setting of norms, rules and values was initiated. Executives from Battelle, OSU (two deans), KnowledgeWorks, the Educational Council, and COSI went to Tacoma, Washington, in order to attend a conference of the Coalition of Essential Schools. During those five days, the group discussed the main tenets of the Metro project including financial and space requirements. Since each of them served as representatives of their respective organizations they could make promises on behalf of those organizations. As the result of the meeting in Tacoma, the group hammered out major commitments: Ohio State University was responsible for providing space, and Battelle was responsible for providing funding. Another critical decision reached during the Tacoma meeting was the
identification, based on the recommendation of the KnowledgeWorks representative, of the future Metro school principal.

**Figure 5.4: Setting norms, rules and values in Metro network (idea mapping network)**

The Tacoma meeting is an excellent example of setting norms, rules and values. During the meeting, the group of executives defined the basic operating parameters of Metro High School including “size, focus, learning modes, early college credit, and replicability” (Hunter & Agranoff, 2008, p. 49). In addition, the group assigned the different roles and responsibilities necessary for project planning and implementation and conducted negotiations that eventually defined the structure of the network. The importance of this Tacoma meeting is that this group of executives did not “collapse” as the network evolved. On the contrary, it was transformed into a governing body, later called the Metro Partnership Group (MPG). As mentioned previously, MPG effectively maintains the unique public-private partnerships, oversees and supports the Metro curriculum, programs, and operations, and transmits knowledge to the larger community.
The development of the Metro school philosophy, or guiding principles, is another example of setting norms, rules and values. These principles were not simply borrowed or benchmarked from experience of other STEM schools in the United States; they were developed during facilitated discussions in an atmosphere of genuine searching for innovation and of exploring the divergent views and solutions offered by the members to address the “wicked policy problem.”

The philosophy of the Metro High School project combines the Common Principles of the Coalition of Essential Schools and the tenets of STEM education. These ten principles are well known to the pedagogic community and include:

1. Learning to use one’s mind well
2. Less is more, depth over coverage
3. Goals apply to all students
4. Personalization
5. Student-as-worker, teacher-as-coach
6. Demonstration of mastery
7. A tone of decency and trust
8. Commitment to the entire school
9. Resources dedicated to teaching and learning
10. Democracy and equity (Coalition of Essential Schools, 2012)

A full description of the Common Principles of the Coalition of Essential Schools can be found in Appendix C.

The concept of STEM (Science, Technology, Engineering and Math) is rooted in the concerns of politicians, leaders of the business community and educators regarding
the failure of high school systems to prepare students to be successful at work and in
further academic studies, particularly in science and technology and their applications.
The growing demands for localized knowledge in the global economy necessitate the
availability of a diversified, creative and innovative labor force. STEM education is
widely mistaken to be concerned only with pedagogy. In fact, STEM education also
incorporates “new strategic approaches and different forms of public and private
partnerships at the local level with support from state and national resources” (Hunter &

Figure 5.5: Metro Concept: Triangle of Issues

The creation of the cornerstones of the Metro philosophy is another example of
setting norms, rules and values. These cornerstones were graphically described by one of
the network founders as a “triangle of issues,” shown in Figure 5.5. According to this
network founder, at the apex of this triangle is the goal of “start small, stay small.” The
other legs and the content of the triangle were described as follows: “One leg involved
autonomy (from a school district) of organization/jurisdiction. The other leg involved the CES principles. Inside the triangle was the goal [of] creat[ing] a small, highly personalized, intellectually vibrant school.” These four cornerstone statements were later blended with the concepts of STEM education to establish the main tenets of the Metro school philosophy and can be found in Appendix D.

In sum, one can clearly see that setting norms, rules and values is another vital process of network development at the planning stage. As a result of this process, the structure, rules, norms and values of the network are defined. These “prevailing values and norms” can then guide the interactions of network participants in the various facets of the network so that it can operate efficiently and effectively.

**Developing and building trust**

Developing and building trust is another crucial process that can be observed at various stages of network evolution, but it is most prominent in the planning stage, where relations are still fragile. Building trust is essential in the process of development of public management networks since they conventionally do not have a legal charter (Agranoff & McGuire, 2001a) to ensure a legally based legitimacy. Metro High School is no exception; it does not have any legal legitimacy. Unlike Metro High School, states and school districts grant a legal charge to chapter schools, and a private school is licensed by the state and governed by a board of directors. In the case of Metro, trust must be developed to provide a foundation for the interactions of network partners who represent different sectors (McGuire, 2006).
Trust among network actors does not start from ground zero. The previous business and institutional linkages of network founders always serve as a foundation for building and developing trust among other network partners. About 25 percent of discussants pointed to the role of the institutional linkages between Battelle and Ohio State University in building trust at the planning stage. As one of network founders of Metro High School said, “High in the hierarchy at Battelle and Ohio State University there are a lot of trust-based relationships. After that level, there is a lot of commitment to expanding it.” Similarly, one of the network partners of the Metro High School project commented on the relations of Battelle and Ohio State University in building trust:

> There is institutional trust between Battelle and Ohio State University, based on reputation and performance. This is most true of Battelle. With Ohio State University there is always skepticism when higher education gets their hands on public schools. “What is in it for them?” But nevertheless trust has been building.

Personal and social relations among the network founders also contribute to the development of trust at the planning stage. One of the Tacoma meeting participants commented on the importance of social relations and building trust:

> Using settings away from work also helped … it established common ground. For me, “I did not have skin in the game.” OSU was not in first. But “over wine” I could say, “look, this is what I need.” The social time builds trust. Too many partnerships overlook building the relationships.

Establishing constant and regular communication contributes to building and developing trust among network partners. Trust is built via various communications including meetings, discussions, roundtables, workshops, and settling disagreements.
When, during the planning stage of Metro, the network partners had some disagreements and wrangles, network founders asked them to lay out the issues and then served as arbitrators. As one of the network champions noted, in group planning Metro has “proven that they can resolve their differences in a constructive way.”

Regular meetings at the various levels also helped build trust both the planning and implementation stages. As one of the superintendents, a member of the Educational Council said, “Most trust is borne out of a steady involvement.”

The process of building trust is intertwined with other processes of network development and management. Setting norms, rules and values appears to be closely connected with building trust among network partners. This can be inferred from the comments about the content and importance of the Tacoma meeting. Some participants noted that it was a “trust-builder” where all interested parties “put out their agenda” and overcame their mistrust of some network partners. For example, some participants were concerned about OSU’s history of mistrust and its gigantic size. However, “the willingness to be honest, and the time-consuming process of forming partnerships helped” to overcome mistrust (from the interview of a network partner who participated in the Tacoma meeting).

Developing a greater value that surpasses the individual interests of the network partners as a part of setting norms, rules and values undoubtedly contributes to the development of trust among the network actors at the very beginning of network development. As one of the network partners participating in the planning stage noted:

We were committed to a deep and long-lasting project that would bring us closer to campus and that would forge something of great value. That led us into a
working partnership around Metro. It has helped us to learn the culture of universities. As I became the Battelle agent and worked with OSU they found they could trust me, as an ice cutter, and that Battelle delivers on its commitments. This led to other bridges as we “framed something” that worked for all.

Activating key persons is also directly related to building and developing trust. According to the observations of several network partners, trust is built by looking for new partners and making different connections with them. A network participant representing a learning center provides the following recommendations on building and improving trust within public management networks based on the example of Metro High School:

1. Continue the efforts to link people.
2. Join people together.
3. Find out what ties newly joined network participants have

Based on what was discussed above, one can clearly see that building trust among the core members of the Metro network is also an important process of network development at the planning stage. As is shown in Figure 5.6, building and developing trust rests on institutional, personal and social linkages that solidify the working relationships.

Trust is also built on constant communication, especially at times when early disappointment of the process takes precedence. Trust especially thrives when network founders develop a compelling vision and contribute to a greater value that subordinates
individual goals and values of organizations participating in the public-private partnership.

**Figure 5.6: Elements of trust building**

The event-state network shown in Figure 5.7 neatly summarizes all the processes predominantly leading to the formation of networks. The identification of key individuals and the identification of resources was essential for the development of Metro. Two network champions, the president of Ohio State University and the vice president of Battelle started bringing together potential network actors who had the resources necessary for the formation of the Metro network.
Figure 5.7: Network processes at the planning stage

- **Interest in math and science school**
- **Regular breakfast meeting between Battelle and OSU top managers**
- **Math and Science School Proposal**
- **Recruitment of two former teachers, a student and a science expert**
- **Tacoma meeting**
- **Core of Metro network is established**
- **Educational Council experience of running high schools**
- **Identifying new actors**
- **Administrative costs of credit transfer, academic counseling are covered by home schools**
- **Clear articulation of vision by network champions**
- **Selling idea to internal and external audiences**
- **Mobilizing corporate engagement of Battelle, OSU & their stakeholders**
- **Public announcement about partnership among network founders**
- **PR campaign about Metro School**
- **Mobilizing community**
- **Town hall meetings**

- **US$ 200,000 grant from the Gates Foundation**
- **KW provided $1 M funding, college tuition grants**
- **$1.2 million lease of class facilities by OSU**
- **Battelle’s $600,000 for first three years of Metro operation**
- **Tuition for 99 students in the 1st year and for 204 students in the 2nd year (EC)**

- **Previous business and institutional linkages**
- **Personal and social relations**
- **Regular meetings of network founders**
- **Trust building**
- **Clear articulation of vision by network champions**
- **Selling idea to internal and external audiences**
- **Mobilizing corporate engagement of Battelle, OSU & their stakeholders**
- **Public announcement about partnership among network founders**
- **PR campaign about Metro School**
- **Mobilizing community**
- **Town hall meetings**

- **Basic operating parameters of Metro**
- **Assigning different rules and positions**
- **Reaching agreements**
- **Defining the network structure**
- **Development of Metro School philosophy**
- **Concept of Metro**
- **Start small, stay small principle**
- **Autonomy**
- **Coalition of Essential Schools principles**
The search for resources started right after the breakfast meeting of top managers from Battelle and OSU and continued until the time Metro opened in the fall of 2006. Mobilizing activities were also present throughout the development of the Metro network to ensure internal and external support, especially in those fragile stages of development where public management networks are unstable and are in great need of support by various constituencies. Setting norms, rules and values was another vital process of network development at the planning stage, a process that defined the structure, norms and values of the network as well as rules for the future interactions of network participants in the implementation stage. Building and developing trust is closely intertwined with other processes of network development such as the identification of key individuals, mobilizing practices and setting norms, rules and values. Overall, I can conclude that the above-described five processes of network development are consistent with the model of network behaviors developed by Agranoff and McGuire (2001b).

5.4 Network processes at the implementation stage

Analysis of the guided discussions with the key representatives from the 17 organizations involved in the Metro school project has shown that all network processes identified at the planning stage were found at the implementation stage as well. However, the intensity and level at which these processes took place is quite different from that of the planning stage. A summary of network processes at the implementation stage, broken down chronologically in the event listing (Miles & Huberman, 1994), can be found in Table 5.2.
Table 5.2: Network processes at the implementation stage

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Identification of key individuals</strong></td>
<td><strong>Identification of key resources</strong></td>
<td><strong>Mobilizing activities</strong></td>
<td><strong>Setting norms, rules and values</strong></td>
<td><strong>Building and developing</strong></td>
</tr>
<tr>
<td>Recruitment of lead teacher</td>
<td>OSU conducts inclusive town hall meetings</td>
<td>Development of Curriculum</td>
<td>Regular meetings and discussions</td>
<td></td>
</tr>
<tr>
<td>Searching for learning cites</td>
<td>Organization of curriculum teams in six fields: physical sciences, fine arts, foreign language, math, social studies, and language arts</td>
<td>Development of admission rules</td>
<td>Making connections with new actors</td>
<td></td>
</tr>
<tr>
<td>Engagement of 16 school districts by PAST</td>
<td>Setting norms, rules and values</td>
<td>Determining school districts for enrollment by EC</td>
<td></td>
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<tr>
<td>Spring and summer 2006</td>
<td>Spring and summer 2006</td>
<td>Spring and summer 2006</td>
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<tr>
<td><strong>Identification of key individuals</strong></td>
<td><strong>Identification of key resources</strong></td>
<td><strong>Mobilizing activities</strong></td>
<td><strong>Setting norms, rules and values</strong></td>
<td><strong>Building and developing</strong></td>
</tr>
<tr>
<td>Recruitment of six faculty</td>
<td>Battelle provides funds for remodeling building for Metro</td>
<td>Development of admission rules</td>
<td>Regular meetings and discussions</td>
<td></td>
</tr>
<tr>
<td>Searching for learning cites</td>
<td>First town hall meeting for students and parents</td>
<td>Determining a fee scheme by Educational Council</td>
<td>Making connections with new actors</td>
<td></td>
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<tr>
<td>Contracting with Learning Partners</td>
<td></td>
<td>Formalization of Metro's Partnership Group</td>
<td></td>
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<tr>
<td><strong>Identification of key individuals</strong></td>
<td><strong>Identification of key resources</strong></td>
<td><strong>Mobilizing activities</strong></td>
<td><strong>Setting norms, rules and values</strong></td>
<td><strong>Building and developing</strong></td>
</tr>
<tr>
<td>Addition of new learning cites – SWACO, COSI, mayor’s office</td>
<td>Provision of teacher mentorship by KW</td>
<td>Internships and learning projects</td>
<td>New actors join the network (Learning Partners)</td>
<td></td>
</tr>
<tr>
<td>Engagement of teachers and students in the process of learning</td>
<td>Engagement of public goods – public libraries and museums</td>
<td>Opportunity for learning outside of the school walls</td>
<td>Developing joint expectations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using inexpensive contracts – Metro students take classes at OSU for a reduced fee</td>
<td>Constant work with 16 school districts regarding credit conversion, student discipline &amp; counseling</td>
<td>Alignment of school superintendents and school boards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>External contracts – food and counseling</td>
<td>Counseling of students by OSU interns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developing different mechanisms and policies for grading, recruitment, credit conversion, and reporting</td>
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</tr>
</tbody>
</table>
Identifying key persons at the implementation stage

Identification of key persons, or activation (Agranoff & McGuire, 2001b), cannot be considered to be a process exclusive to the planning stage, as it occurs also in the implementation stage. Evidence for this can be found during the implementation stage when the governing and administrative cores of Metro High School were searching for new learning sites or centers, for example libraries, museums and public programs. Throughout the whole period of Metro High School’s existence, the process of identifying key persons has been present in different forms as the various actors necessary for the maintenance and sustainability of the network have been added or removed. The addition or subtraction of new players is caused by the dynamic network processes, changing environmental conditions, rearrangements of power structure and decisions of network leaders or champions (Klijin, 1996; Klijin & Teisman, 1997). A graphic representation of the process of identifying actors in the implementation stage can be found in Figure 5.8

As the Metro network grows, it requires not only the engagement of new actors but the deactivation of old members who are no longer needed for the survival of the network. Deactivation is a necessary process for changing or rearranging network structures to ensure network effectiveness (Agranoff & McGuire, 2001b). For example, the OSU president was not already involved in the implementation stage of Metro school, since she had already performed the role of the network champion by connecting people, moving the project forward and mobilizing the community. Meanwhile, the implementation stage brought in new network actors such as Learning Centers and Learning Partners.
A unique feature of the Metro school is that student learning often takes place outside traditional classrooms and the instruction of teachers. The students of Metro High School take traditional classes housed at Battelle and Ohio State University, but field-learning experiences are provided by Learning Centers such as the Franklin Park Conservancy, Wexner Center for the Arts, OSU Library, Solid Waste Authority of Central Ohio (SWACO), the Mayor's office, Columbus Art Museum and Center of Science and Industry (COSI). None of these learning centers can boast of being exclusive providers of services due to the mutual dependency and mutual provision of services within Metro’s operation.
Key persons activated at the implementation stage included more than just the new network actors from the learning centers and partners. STEM education requires the engagement of both teachers and students in the learning process. Therefore, teachers and students were prepared to use agility, teamwork, critical thinking, and responsibility and to reflect on the experiences they’d had as the result of working with others or on their own. The PAST Foundation also involved all sixteen school districts by sharing the ideas of STEM education.

**Identifying key resources at the implementation stage**

The activation of the key resources did not stop at the planning stage; it was continued at the operational level starting with preparing the building donated by Ohio State University to the Metro School to finding learning sites, centers and partners. As the Metro network grows, it requires the engagement of new actors as well as the resources necessary for the implementation of new programs and curricula.

The Metro principle of “starting small and staying small” was implemented in practice by contracting for particular services such as food provision and counseling on a small scale and by utilizing public goods and services. On the one hand, Metro uses goods provided for the general public, including museums (Columbus Art Museum and the Center of Science and Industry), parks (Franklin Park Conservancy), libraries (Ohio State University Library) and public organizations (Solid Waste Authority of Central Ohio and the Mayor's office). On the other hand, Metro contracts with organizations to provide resources that significantly decrease the operational costs of the school. For
example, Metro students take some classes at Ohio State University for credits, using publicly subsidized tuition (less than half of the usual tuition).

**Mobilization practices at the implementation stage**

Similar to the identification of key persons and resources, mobilization practices did not stop at the implementation stage. However, the emphasis shifted from working with donors and the general public to working with the learning centers and sites who provided field-learning opportunities and with the 16 school districts who dealt with enrollment, discipline, credit conversion and counseling. A graphic representation of the mobilization practices at the implementation stage is shown in Figure 5.9.

Hands-on learning fully embodies the principles of STEM education and requires a different pedagogical approach from traditional classroom learning. Therefore, Battelle and other learning centers provide the opportunity for “learning outside of the school walls” as well as “experiences [that] go beyond a traditional internship and include demonstrations of problem solving and critical thinking in partnership with the learning lab” (Metro, 2012). Depending on the type of curriculum, Metro students are engaged in various kinds of field learning such as internships and research projects. Math- and science-oriented students work with engineers at Battelle on robotic projects or take internships at the Solid Waste Authority of Central Ohio to understand the processes of chemical treatment. In addition, these math- and science-oriented students can take engineering courses at Ohio State University or Columbus State Community College as part of the College Access program. Humanities-oriented students can join the Journalism Club, which produces a newsletter, or help a local newspaper editor. Like math and
science students, they can take journalism courses for credits at Ohio State University or Columbus State Community College as part of the aforementioned College Access program.

**Figure 5.9: Mobilization practices at the implementation stage (actor-event network)**

Notes: bubbles represent actors, rectangles represent events
The provision of counseling for Metro students is another example of mobilizing resources at the implementation stage. Metro students have access to the services of counselors in training (CITs) as a part of OSU’s school counselor education program. These counseling services have proved to be very useful for Metro students in their second year, which is when they have their first college experience and must learn to balance their high school requirements and their university courses. The counselors in training are supervised by an OSU counselor who is present at Metro one day a week for counseling, supervising and class appearances. CITs do counseling interventions and work 20 hours a week. It is interesting to note that CITs are all unpaid interns. Metro High School pays only a symbolic fee to OSU for the supervision of these CITs.

Overall, it is clear that the Metro network is constantly searching for new funding that can be provided at the local level to make sure that Metro is independent of foundation funding and grants. Metro’s reliance on multiple funding sources is also indicative of how much Metro values collaboration, as they avoid monopolization by any one provider to ensure the high quality of the services provided by the funding organizations, whether they represent the public, private or nonprofit sectors.

**Setting norms, rules and values at the implementation stage**

Setting norms, rules and values penetrates the work at every stage of network development. However, the focus of this process shifts from developing fundamental principles and the philosophy of the Metro school to the development of operational rules, standard operating procedures, and other regulations. A graphic representation of setting norms, rules and values at the implementation stage is shown in Figure 5.10.
Notes: bubbles represent actors, rectangles represent events

As soon as it was publicly announced that Metro High School would open in the fall of 2006, welcoming 100 students from 16 school districts in Franklin County, the implementation of the project had begun. The Tacoma group sketched an organizational chart and recruited a school principal and lead teacher from a small school in California.

The newly hired lead teacher, the curriculum teams, the faculty of Ohio State University, representatives from Battelle and from local school districts worked on the curriculum and model of enrollment. Work on the curriculum was broken into the following fields: physical sciences, fine arts, foreign language, math, social studies, and
language arts. After the curriculum teams met every week for the three weeks, the results of the group work were presented to the advisory group, which was the predecessor of the Metro Partnership Group and the Educational Council. In turn, this advisory group also held regular meetings to discuss the issues related to location, building, grading policies and reporting procedures.

In the initial stage of implementation, the Educational Council was actively engaged in the procedures for selecting students and for funding Metro High School. After several heated discussions, it was agreed that Metro would be financed by the fees sent by the school districts for each student they sent to Metro. The amount of this fee was approximately equal to that given as state aid for public-school students in the state of Ohio.

While the implementation stage was under way, the Metro Partnership Group, Educational Council and school districts continued setting norms and rules by developing different mechanisms and policies for grading, recruitment, credit conversion, and grade reporting. The process of setting norms, rules and values no longer dealt with defining the fundamental principles of Metro High School’s existence, as it had at the planning stage, but focused on the development of the operational rules and procedures necessary for the effective functioning of the administrative systems.

**Building and developing trust at the implementation stage**

Like the other network development processes described above, developing and building trust does not stop after the planning stage. However, the level at which network participants engaged in trust building at the implementation stage shifted from the top of
the Metro network down to its operational core and school districts. Learning Partners and the Metro school staff were constantly engaged in the process of trust building as new network actors joined the Metro network at the implementation stage. For example, the supervisor of Counselors in Training (CIT) from Ohio State University indicated that the development of trust between Metro High School and the CITs was achieved through the development of expectations:

Metro and this program need to work out exactly what a CIT can and cannot do in a building where there is not a real counselor, as is the case with Metro. My CITs are confronted with issues that belong to a seasoned counselor. Are they to deal with these issues? We can’t let that happen because they are not counselors. They are learning to be counselors. Additionally, some issues are not in the realm of what a seasoned counselor would do.

School district representatives sitting on the Educational Council also must develop trust when they interact with school boards and the schools themselves. As Metro evolves, the alignment of school superintendents and school boards is still in process. Even though all of the superintendents confirmed participation in the Metro project, not all of the school boards agreed. According to one of the network founders:

In 2 or 3 of the boards there is not the same level of understanding and commitment to Metro. Some board members see Metro as a diversion, particularly of money. This has led to a rear guard of board members who are active but not informed. They are “unburdened by facts” but went ahead and opposed Metro.

Clearly, developing and building trust is a network development process still taking place during the implementation stage. As in the case of trust building at the
planning stage, development of trust at the implementation stage is closely connected with the identification of key persons and with setting norms, rules and values.

To sum up, many of the processes identified at the implementation stage include the same network processes that were observed at the planning stage (see Figure 5.11 for an event-state network (Miles & Huberman, 1994)) depicting the processes of network development at the implementation stage). Even the process of identifying key persons is also present, though in a different form, as now different actors are added or removed as needed for the maintenance and sustainability of the network. Some actors become obsolete in terms of their role and contribution to the network, whereas the emergence of the operational core of Metro and the Learning Partners was necessary for the implementation of the Metro concept. The identification of key resources was based on the fundamental Metro principle of “starting small and staying small.” The efficiency of Metro is rooted in the practices of contracting for certain services, such as food provision and counseling, on a small scale and using public goods and services such as museums, libraries and parks.

Mobilizing practices were also found at the implementation stage. The focus of the mobilizing practices, however, shifted from working with external audiences such as donors and the general public to the implementers of the Metro concept. These implementers include learning centers and sites who provide field-learning opportunities, and the 16 school districts who deal with enrollment, discipline, credit conversion and counseling. Norms, values and rules developed at the implementation stage have more tactical characteristics and are in fact the standard operating procedures for the various facets of Metro’s existence.
Figure 5.11: Network processes at the implementation stage

- Hiring a lead teacher
- Hiring six faculty
- Engagement of 16 school districts
- Engagement of teachers and students in the process of learning
  - Network founders
  - Searching for learning sites and partners
  - Contracting Learning Partners
  - Addition of new learning sites
- Organization of curriculum teams in six fields
  - Development of Curriculum
  - Credit conversion, student discipline & counseling
    - Formalization of Metro's Partnership Group
  - Battelle funds for remodeling building for Metro
  - Determining school districts for enrollment
  - Town hall meetings with parents and students
  - Determining a fee scheme
- Interactions of Educational Council and school districts
  - Policies for grading, recruitment, credit conversion, and reporting
  - Development of expectations between Metro and Learning Partners
- Development of expectations between Metro and counselors
- Interactions of Educational Council and school districts
- Development of expectations between Metro and counselors

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<thead>
<tr>
<th>Identification of key individuals</th>
<th>Identification of key resources</th>
<th>Mobilizing activities</th>
<th>Setting norms, rules and values</th>
<th>Developing and building trust</th>
</tr>
</thead>
</table>

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Building and developing trust continues to be present at the implementation stage, and the principles identified at the planning stage still hold true. However, the level of this network development process moved from the strategic level to the operational level, so that interactions take place with Learning Partners and school districts rather than with major partners.

**Summary**

This chapter presents the network processes required for the formation and development of public management networks, based on the case of Metro High School, a landmark STEM high school in Columbus, Ohio. After analyzing the qualitative data using a grounded theory approach, the following network development processes were distinguished: identification of key individuals, identification of key resources, mobilizing activities, setting norms, rules and values, and developing and building trust, each of which is consistent with the model of network behaviors developed by Agranoff and McGuire (2001b). I conclude that the network processes identified at the planning stage were found at the implementation stage as well. However, the intensity and level at which these processes took place was quite different from those of the planning stage. The network processes at the planning stage were carried out at the strategic level. The key persons identified at the planning stage were primarily those who founded the network and who today are involved in governing the network. Similarly, key resources were strategically identified and used. The process of setting norms, rules and values focused on the fundamental principles of network existence such as the mission, vision and philosophy of Metro High School. Trust was also built at the strategic level, starting
with the previous institutional linkages between OSU and Battelle. The process of trust building is also a vivid example of where other processes of network development, such as identification of key persons and setting norms, rules and values, intersect.

However, those network development processes that were observed at the implementation stage had a more tactical and operational character. Identification of key persons included both the inclusion of operational partners and the exclusion of strategic partners who had already performed his or her significant role during the planning stage, and who was not really necessary during the implementation stage. Mobilizing practices were aimed at involving various audiences in the operational life of Metro school as well as strengthening the relationships between the various stakeholders who directly or indirectly participate in the governing of the network. Similarly, the setting of rules, norms and values contributed mainly to the development of administrative and management control systems.
CHAPTER 6 : STRUCTURAL CONFIGURATIONS OF PUBLIC MANAGEMENT NETWORKS OVER TIME

This chapter is devoted to testing the theoretical framework of the structural development of public management networks over time using relevant theories at different network levels (actor, dyadic, triadic and global). These hypotheses were developed using a multitheoretical multilevel modeling approach (Contractor et al., 2006) and incorporate relevant sociological, organization science and public management theories. The detailed explanations of these hypotheses were provided in Chapter 3: Theoretical framework of structural development of public management networks. The results of testing these structural hypotheses will be presented in two stages. First, I will provide the results of an exploratory network analysis to highlight the structural properties of the Metro school network at each stage of development to test the structural hypotheses at the global, dyadic and individual levels of the network. Second, I will cover the confirmatory network analysis, using triadic census analysis (Wasserman & Faust, 1994) and exponential random graph modeling (ERGM) to test the structural hypotheses at the different stages of network development and at the different network levels (actor, dyadic, triadic and global).

6.1. Structural evolution of the Metro network at the global level

Exploratory network analysis consists of a visual analysis and an analysis of structural properties based on the traditional measures of social network analysis at the
global network level and allows one to describe the structural changes of public management networks over time and to make preliminary conclusions about the structural hypotheses at the global level.

A comparative analysis of visualizations of the working relations among 28 key network partners of Metro High School at two different points of development shows the tendency of public management networks to have particular degrees of centralization, density and reciprocity as the network evolves. A visual representation of the working relations among those 28 key network partners can be found in Figures 6.1 and 6.2.

A visual inspection of Figure 6.1 shows that representatives of foundations—OSU and private organizations along with the school—end to be in the center of the network at the planning stage. However, the Metro network at the planning stage appears to be less centralized than the Metro network at the implementation stage (see Figure 6.2 below). It appears that several centers are distinguished at the planning stage, represented by the CEOs of Ohio State University, Battelle Memorial Institute, KnowledgeWorks and the Educational Council and the key managers of the organizations that founded Metro High School, thus making the network decentralized. Relations among the network founders tend to be more reciprocated than those between the representatives of OSU and the learning partners. The highest level of reciprocal or symmetrical relations is observed among the network champions (the CEO of Battelle, the president of Ohio State University, the CEO of the Educational Council, and the principal of Metro High School.
Figure 6.1: Metro network at the planning stage

Notes:
Gender: male – green; female – blue
Size of the node: bigger nodes indicate presence of previous interorganizational network experience

It is necessary to note that the digraph representing the working relations at the planning stage contain 13 isolates—nodes of a network that are not connected to other nodes or network players. In this particular case, these are network actors who did not play any role in the formation of Metro School. Most of them include the school superintendents who are members of the educational council, employees of Metro School, some Ohio State University deans and some learning partners who joined Metro School at the later stage of implementation (after the fall of 2006).
Figure 6.2: Metro network at the implementation stage

A simple glance at the Metro network at the implementation stage shows it to be more centralized than the network at the planning stage (see Figure 6.2). At the implementation stage, the Metro network has fewer centers with many connections. The most central players with many linkages at this stage include the principal of Metro High School, the CEO of the Educational Council, a manager of the PAST Foundation, a top Battelle manager, and a Battelle project manager in residence at the Metro High School project. The network participants located on the periphery include the members of the Educational Council, employees of OSU involved with learning partners and in counseling, and those learning partners who provide field learning experiences.
A comparison of the visualizations of the Metro High School network indicates that the relations between the 28 key network actors tend to be more reciprocated at the planning stage than at the implementation stage. Only four network actors at the implementation stage enjoy the highest level of reciprocation: the director of KnowledgeWorks, the CEO of the Educational Council, a top Battelle manager and one school district superintendent.

Compared to the digraph representing working relations at the planning stage, the digraph of the Metro School network at the implementation stage depicts only isolates. This time they are represented by the former president of OSU and the CEO of Battelle. As they indicated in the guided discussions, their duties had been largely fulfilled at the formation stage, and their engagement with Metro School had discontinued at the implementation stage.

The results of the visualizations of the working relations in the Metro School network at the planning and implementation stages concur with the analysis of the basic measures of the structural properties at the global network level, which can be found in Table 6.1.

<table>
<thead>
<tr>
<th></th>
<th>Planning</th>
<th>Implementation</th>
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<tr>
<td>Centralization (outdegree)</td>
<td>20.17%</td>
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<tr>
<td>Centralization (indegree)</td>
<td>35.53%</td>
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<td>Density</td>
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<td>Reciprocity</td>
<td>50.98%</td>
<td>26.04%</td>
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<tr>
<td>Transitivity</td>
<td>64%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Table 6.1: Basic measures of Metro High School network at different stages of development
As predicted in Hypothesis 1, centralization is higher at the implementation stage than in the planning stage. Outdegree centrality rose from 20.17% to 29.49% as the Metro network evolved. Similarly, indegree centrality more than doubled, from 35.53% in the planning stage to 79.42% in the implementation stage.

It may be concluded that the planning-stage network is less centralized, so that few actors occupy central positions or have the ability to mobilize the network efficiently to create a network structure. A low centralization also means that many participants may be in the position of broker, connecting unconnected members of the network by introducing them to each other. This corresponds to the activating and mobilizing processes that occur intensively in the planning stage. The implementation stage, however, is characterized by the inclusion of new actors and the increased centrality of the Metro principal. High centralization scores indicate a higher level of power concentrated in the hands of many actors, which provides a more adequate process for managing or “managing within” the network (Agranoff, 2007). Thus, I can tentatively confirm Hypothesis 1: As public management networks develop over time they tend to become more centralized.

The density of the Metro network increased during its evolution, as was predicted in Hypothesis 2. At the planning stage the density of the Metro network amounted to about ten percent of all possible connections, whereas at the implementation stage, the density rose to sixteen percent. This six percent increase can be explained by the inclusion of new network actors such as members of the Educational Council, employees of Metro School, some deans from Ohio State University and some Learning Partners. The increase in density can be explained by the level of collaboration, which increases
with the growth of trust. This finding regarding the increase of density over time coincides with the results of a study by Provan, Isett, & Milward (2004), who examined the evolution of community mental health networks and concluded that collaboration was accompanied by an increase in the number of ties and by a stronger multiplexity of ties over time. Thus, I can tentatively confirm Hypothesis 2: As public management networks develop over time, network density tends to increase.

The transitivity differs between the planning and implementation stages of the Metro network as well. Hypothesis 3 predicted that the Metro network at the implementation stage would tend to be less hierarchical, measured by a lower transitivity of the network at the global or whole network level. The transitivity index of the Metro network at the planning stage was about sixty four percent, while the same index at the implementation stage came to only forty six percent. This eighteen percent decrease in transitivity suggests that the Metro school network became less hierarchical and more decentralized. It can be seen from Figure 6.2 that the network structure of Metro High School includes several centers that govern and manage the school. Therefore, it may be concluded that the power differentials among the network members are leveled off at the implementation stage. Additionally it may be inferred that the implementation network has a few stars, i.e., nodes that have many incoming preferences that are not reciprocated. This analysis tentatively confirms Hypothesis 3a, a structural tenet of the theory of structural development of public management networks over time: As public management networks develop over time, they tend to become less hierarchical (transitivity).
6.2. Structural evolution of Metro network at the triadic level

Structural hypotheses at the triadic level can be tested using the triadic census analysis (Wasserman & Faust, 1994), which was extensively described in Chapter 4. As I mentioned before, structural hypotheses at the triadic level are based on balance theory (Heider, 1958) and the theory of generalized exchange (Heider, 1958). These hypotheses allow researchers to test the propensity of public management networks to exhibit signs of hierarchy, resource exchange, and stability at the different stages of development.

The triadic census for the planning and implementation networks was obtained by using Pajek (Batagelj & Mrvar, 1996), the results of which can be found in Table 6.2. The pre-project network was not included in the analysis because it is based on another relation—personal knowledge of other actors before the project. Below, I provide the results of testing Hypotheses 4, 5 and 6.

Hierarchical triads. The results of the triadic census analysis coincide with the results of testing the structural hypothesis of transitivity at the global level. Higher transitivity is found in the planning stage, since the number of hierarchical triads 210 and 120C is much higher at the planning stage than would be expected by chance (Wasserman & Faust, 1994). The number of 210 triads (they have three transitive triples) at the planning stage is 138 times higher than would be expected by chance, whereas at the implementation stage the number of 210 triads is 17 times more than would be expected by chance. Similarly, the number of 120C triads (they have two transitive triples) at the planning stage is 1.34 times more than would be expected by chance, whereas at the implementation stage the number of 120C triads is 0.3 times more than it is expected by chance (statistically insignificant). Therefore, it can be concluded that the
Metro High School network at the planning stage exhibited a structural tendency towards hierarchy because of the large number of transitive triads.

Table 6.2: Triadic census for Metro High School network at the stages of planning and implementation

<table>
<thead>
<tr>
<th>Type of Triad</th>
<th>Planning Network</th>
<th>Implementation network</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of triads</td>
<td>Expected number</td>
</tr>
<tr>
<td>1 – 003</td>
<td>2233</td>
<td>1719.62</td>
</tr>
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<td>2 – 012</td>
<td>421</td>
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<td>3 – 102</td>
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</tr>
<tr>
<td>4 – 021D</td>
<td>9</td>
<td>66.34</td>
</tr>
<tr>
<td>5 – 021U</td>
<td>15</td>
<td>66.34</td>
</tr>
<tr>
<td>6 – 021C</td>
<td>10</td>
<td>132.69</td>
</tr>
<tr>
<td>7 – 111D</td>
<td>50</td>
<td>15.05</td>
</tr>
<tr>
<td>8 – 111U</td>
<td>14</td>
<td>15.05</td>
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<td>9 – 030T</td>
<td>6</td>
<td>15.05</td>
</tr>
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<td>10 – 030C</td>
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<td>5.02</td>
</tr>
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<td>11 – 201</td>
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</tr>
<tr>
<td>12 – 120D</td>
<td>18</td>
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</tr>
<tr>
<td>13 – 120U</td>
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</tr>
<tr>
<td>14 – 120C</td>
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<tr>
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<tr>
<td>16 – 300</td>
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</tr>
</tbody>
</table>

Note: Parameter is calculated by the following formula: (observed number of triads – expected number of triads)/expected number of triads

Again, one can see signs of strong hierarchy observed in the planning network, where it required the underlying process of establishing the implementation structure. At the planning stage, network participants are intensively engaged in establishing the basic network structure and developing norms and rules. Therefore, Hypothesis 3b, a structural tenet of the theory of structural development of public management networks over time, is confirmed: As public management networks develop over time, they tend to become less hierarchical (fewer hierarchical triads).
The 030C cyclical triads are interesting in terms of the analysis of information exchange. As I mentioned before, Contractor, Wasserman and Faust (2006) argue that the presence of cyclical triads can explain the flow of information, which could be critical at both stages—planning and implementation. However, the number of 030C cyclical triads both at the planning stage and the implementation stage is 1.0 times less than would be expected by chance. The generated data during the process of triadic analysis predicted five cyclical triads at the planning stage and 16 cyclical triads at the implementation stage. However, none of the networks at the planning stage or the implementation stage had any cyclical triads. This contradicts the usual process of managing networks at the operational level, since a cyclical flow of information is expected, especially during the implementation stage. Over-prediction of cyclical triads leads us to believe that both planning and implementation networks can experience a smooth flow of information in direct and reciprocated relationships.

It was originally predicted that the planning stage would be characterized by the direct exchange of resources, which is supposed to result in the presence of few cyclical triads. Meanwhile, the implementation stage was predicted to have more cyclical triads due to indirect generalized exchange, where network participants are engaged in the exchange of resources, such as giving and receiving information, giving and receiving financial resources, and related exchanges. The results of the triadic census analysis, however, suggest otherwise. The previous research on cyclical triads provides limited support for the importance of cyclical triads in the presence of generalized exchange (Bearman, 1997). An experimental study by Yamagishi & Cook (1993) suggests that networks are engaged in the indirect exchange of resources by providing them to other
actors, while the studies of Rank et al. (2010) and Lazega & Pattison (1999) confirm the idea that direct exchanges exist irrespective of the stage of the network development. A study by Lazega & Pattison (1999) of coworking, advice and friendship relationships among lawyers in one Northeastern firm suggests that cyclical triads play an insignificant role in determining the working relationships of lawyers. Similarly, Rank et al. (2010) found cyclical triads to be insignificant in intraorganizational networks, arguing that “actors take their own benefit into close consideration when establishing cooperative ties with others” (p. 757). Finally, the study by Contractor et al. (2006) on the CRADA research project, an interorganizational network consisting of three US agencies and private sector organizations, suggests an insignificant effect of cyclical triads in the p* modeling of public management networks. Therefore, the results of the triadic census analysis did not confirm Hypothesis 4 regarding an increase of cyclical triads at the implementation stage compared to the planning stage.

Balanced triads point to the stability and sustainability of public management networks. It was predicted that the planning stage should be dominated by balanced triads of type 300, where the relationships among three actors are fully reciprocated, whereas the implementation stage of network development would be inclined to fewer numbers of balanced triads due to the established network structure and the agreed rules of the network.

The results of the triadic census analysis suggest that both planning and implementation networks tend to be balanced according to balance theory (Holland and Leinhard, 1975) since the 300 triad (completely mutual triads) appears more than would be expected by chance (see Table 6). In the planning network, the number of 300 triads is
7381, more than expected by chance. As for implementation network, the number of 300 triads is 199, more than expected by chance, and a statistically significant result. The huge presence of mutually reciprocated triads at the planning stage indicates that the Metro High School network was less vulnerable to exogenous shocks from the environment. At the same time, there were several network centers responsible for inviting new members into the network and developing norms and rules for the interactions of network actors. At the implementation stage, the number of balanced triads significantly decreased since the Metro network had been stabilized and was governed or managed by two centers. Thus, Hypothesis 5 is confirmed: As public management networks develop over time, they tend to be less balanced and stable (less fully reciprocated triads tend to occur).

6.3. Structural evolution of Metro network at the dyadic level

Structural hypotheses at the dyadic level can be tested initially by the techniques of exploratory social network analysis (Contractor et al., 2006). Exploratory network analysis allows for looking at reciprocity from two perspectives: as a global measure and as a dyadic measure by the means of dyadic analysis (Wasserman & Faust, 1994).

Reciprocity, as mentioned, serves as an indicator of the development of trust, mutual support and exchange of resources among the network participants. Table 5 suggests that about 51% of existing working relations at the planning stage were reciprocated, whereas at the implementation stage only 26% were. Thus, as Metro High School evolved, the reciprocity level decreased by half.
As predicted, reciprocity is critical at the planning stage since the network members are engaged in the processes of mobilizing different resources and actors and setting rules, norms and values for the effective future functioning of the network. At this stage, network participants were engaged in the processes of strategic decision making, which required the development of reciprocity norms to ensure that every actor will contribute and benefit from this network endeavor (Rank et al., 2010). At the implementation stage, reciprocity decreases because strategic actions are already developed and trust is developed. Participants are no longer worried about the benefits of collaboration since they can see the products of that collaboration. In addition, they are already assured that the overall goal of subordinating the individual interests of network actors is achieved by collaborating and cooperating with others (DeLeon & Varda, 2009). Thus, preliminary confirmation of Hypothesis 6 is possible: As public management networks develop over time, reciprocity of ties tends to decrease.

The reciprocity of individual network members at the different stages is also important for understanding the development of strategic norms at the planning stage, especially in terms of network governing and managing. The results of dyadic analysis shown in Tables 6.3 and 6.4 also confirm Hypothesis 8.

Table 6.3 suggests that the highest reciprocity can found in the case of network champions of Metro (100% and 75% of ties reciprocated) and network actors who actively planned the activities of Metro High School. They include the director of KnowledgeWorks (70% of ties reciprocated), the CEO of the Educational Council (60% of ties reciprocated), the principal of Metro High School (58% of ties reciprocated), the dean of OSU’s School of Education and Human Ecology (56% of ties reciprocated), the
vice president of Battelle (56% of ties reciprocated) and an OSU professor who used to be a member of the Metro Partnership Group (a former dean).

Table 6.3: Reciprocity statistics of Metro network actors at the planning stage

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<tr>
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<th>In/</th>
<th>Nonsymmetric</th>
<th>Nonsymmetric/</th>
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<td></td>
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</tbody>
</table>

Notes: All values are proportions
"Symmetric" gives the proportion of ego's undirected contacts with whom ego has reciprocated ties.
"NonSymmetric" is 1 – Symmetric.
"Out/NonSym" gives the proportion of ego's nonsymmetric ties that are outgoing.
"In/NonSym" gives the proportion of ego's nonsymmetric ties that are incoming.
"NonSym/Out" gives the proportion of ego's outgoing ties that are not reciprocated.
"NonSym/In" gives the proportion of ego's incoming ties that are not reciprocated.
Gray areas mean that this respondent was not a network member at this stage of development.
Table 6.4 Reciprocity statistics of Metro network actors at the implementation stage

<table>
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<th>Respondent</th>
<th>Symmetric</th>
<th>Non-symmetric</th>
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<th>In/Nonsymmetric</th>
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</table>

Notes: All values are proportions.
"Symmetric" gives the proportion of ego's undirected contacts with whom ego has reciprocated ties.
"Nonsymmetric" is 1 – Symmetric.
"Out/Nonsym" gives the proportion of ego's nonsymmetric ties that are outgoing.
"In/Nonsym" gives the proportion of ego's nonsymmetric ties that are incoming.
"Nonsym/Out" gives the proportion of ego's outgoing ties that are not reciprocated.
"Nonsym/In" gives the proportion of ego's incoming ties that are not reciprocated.
Gray areas mean that this respondent was not a network member at this stage of development.

Except for the network founders, all of these respondents were involved in the formation of the Metro school and are members of the Metro Partnership Group (see Appendix E for the network roles played by the different respondents). All of these network actors...
were involved in the processes of mobilizing different resources and actors and setting rules, norms and values for the effective future functioning of the network.

The implementation stage is characterized by a significant reduction of reciprocity for many network members (see Table 6.4). The highest reciprocity is found in case of the director of KnowledgeWorks (about 55% of ties reciprocated), who represents the organization responsible for the implementation of CES principles as well as for the facilitation of the partnerships between different actors. He is followed by two members of the Educational Council: one superintendent of a school district (55% of ties reciprocated) and the CEO of the Educational Council (44% of ties reciprocated). The executive director of the PAST Foundation, responsible for organizing and disseminating learning experiences, also enjoys a relatively high level of reciprocity (43% of ties reciprocated). Therefore, it can be concluded that a high level of reciprocity is found in members responsible for governing the Metro school (Educational Council and KnowledgeWorks) or organizing beneficial projects (PAST Foundation).

6.4. Structural evolution of Metro Network at the individual level

Structural hypotheses at the individual level were also initially tested using the techniques of exploratory social network analysis (Contractor et al., 2006). First, I provide the results of the exploratory network analysis using various measures of centrality such as degree centrality and betweenness centrality (Wasserman & Faust, 1994). Second, I analyze the effect of gender, experience of the network, and sector affiliation on the subgroup density of working relationships at the different stages of
network development to test preliminary hypotheses about the effect of the individual characteristics of network actors.

The levels of degree centrality of the Metro network actors at the planning stage suggest the leading roles of network champions and some of the Metro Partnership Group’s members in the formation of Metro High School. It can be seen in Table 6.5 that the Metro High School principal has the highest number of incoming and outgoing ties combined (seven incoming and twelve outgoing ties). She is followed by the director of KnowledgeWorks, who has nine incoming and seven outgoing ties. Therefore, the Metro School principal and the director of KnowledgeWorks are considered to be the most central actors in the planning stage. They are also the in-stars of the planning stage since they have more incoming ties than outgoing ties (Wang et al., 2009).

Other central network actors at the stage planning include the vice president of Battelle (five incoming ties and nine outgoing ties), the dean of OSU’s College of Education and Human Ecology (six incoming ties and eight outgoing ties), the OSU President and the CEO of Battelle (seven incoming ties and seven outgoing ties each), an OSU professor of physics (six incoming ties and six outgoing ties) and the vice president of COSI (eight incoming ties and two outgoing ties).

The role-by-time matrix in Table 6.6 allows one to see the relationship between the degree centrality, positional roles and certain planning processes more closely. It can easily be seen that all of the central network actors participated in the formation of Metro High School and later became members of the Metro Partnership Group, responsible for governing Metro activities. In addition, the principal of Metro High School, the director of KnowledgeWorks, the CEO of the Educational Council, the vice president of Battelle
and the dean of OSU’s College of Education and Ecology were also involved in curriculum planning and development.

Table 6.5: Degree centrality of actors in the different stages of development

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<th>Implementation Stage</th>
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<td>35.52%</td>
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Table 6.6: Degree centrality, network roles and processes at the planning stage

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<th>Roles</th>
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The implementation stage changes the centrality of the network actors and shifts the emphasis to the managing and governing cores that share power in the Metro High School network. The most central network actors are the Metro High School principal and the CEO of the Educational Council, since they have a high number of incoming and outgoing ties combined. They are considered to be in-stars since they receive more ties than they send, which indicate their leadership role in the network (Prell, 2012).
Other central network actors at the implementation stage include the vice president of Battelle (ten incoming ties and twenty outgoing ties, fully reciprocated), the dean of OSU’s College of Biological Sciences and the director of KnowledgeWorks (seven incoming ties and 10 outgoing ties), the dean of OSU’s College of Education and Ecology and the Metro High School teacher of record (twelve incoming ties and two outgoing ties).

Lower centrality scores tend to arise for members of the Educational Council, employees of OSU, and learning partners since they represent the operational core of the Metro network. Thus, we can see that the leading actors in the governing and managing core tend to be the central actors in the implementation stage in terms of degree centrality.

The role-by-time matrix in Table 6.7 allows one to see the relationship between degree centrality and positional roles in the implementation stage as well as some of the processes of network development prevalent for this stage. It can easily be seen from Table 6.7 that all of the most central network actors at the implementation stage are the members of the Metro Partnership Group (except the Metro teacher of record). About fifty percent of the central network actors at the implementation stage are involved in school governance. Almost all Metro school staff and teachers tend to be the central in the network (except the Metro teacher of record). At the same time, learning centers and learning partners tend to be less central in the implementation stage since they represent the operations of Metro school, particularly the provision of learning experiences. A similar picture appears for field-learning projects.
Table 6.7: Degree centrality and network roles at the implementation stage

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<th>Degree centrality Out</th>
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<th>Metro Learning Partner</th>
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</table>
Most of the network actors representing the learning centers and learning partners who are also engaged in providing field-learning experiences have a lower degree centrality compared to MPG and Educational Council members.

Betweenness centrality provides another perspective on the leadership and control of information in the evolution of the Metro network. As mentioned earlier, betweenness measures the degree to which one particular node serves as a bridging point between different network actors (Wasserman & Faust, 1994), thus controlling the flow of information and other processes for managing the network. The results shown in Table 6.8 indicate that the betweenness index in the network increased from about four percent to approximately 23 percent, which was already explained by the presence of new players in the implementation stage.

The highest betweenness score in the planning stage belongs to the CEO of Battelle, a network champion who brought in different players during the planning stage (normalized betweenness score = 4.44). He is followed by the Battelle project manager, a liaison between Metro (normalized betweenness score = 3.7) and Battelle, and the Metro High School principal (normalized betweenness score = 3.64).

The Battelle project manager organized meetings with different network actors and worked with MPG and COSI, whereas the Metro school principal involved all partners, including parents. The CEO of the Educational Council and the director of KnowledgeWorks also have good brokerage positions in the planning stage, since their normalized betweenness scores are 2.5 and 1.71 respectively.
Table 6.8: Betweenness centrality of actors in the different stages of network development

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<th>Implementation Stage</th>
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<td>1.712</td>
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<tr>
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<tr>
<td>21</td>
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<td>22</td>
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<td>23</td>
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</tr>
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<td>25</td>
<td>1.917</td>
<td>0.273</td>
</tr>
<tr>
<td>26</td>
<td>31.2</td>
<td>4.444</td>
</tr>
<tr>
<td>27</td>
<td>0.333</td>
<td>0.047</td>
</tr>
<tr>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Network Centralization Index | 3.92% | 22.66%

Note: Normalized betweenness scores are computed to compare results of different networks.

The implementation stage is characterized by betweenness scores that increased six or seven times as well as by a change of leader. At this time, the highest position in
bridging the Metro network belongs to the vice president of Battelle, who was responsible for mobilizing and maintaining corporate engagements between Battelle and its stakeholders (normalized betweenness score = 26.07). He is followed by the Battelle project manager, a liaison between Metro (normalized betweenness score = 20.35) and Battelle, and the Metro school principal (normalized betweenness score = 19.76). These network actors occupied the same places by betweenness in the planning stage. The Metro school teacher of record is in fourth place since the normalized betweenness score of this network actor is 18.07. This high betweenness score can be explained by the teacher’s responsibility for curriculum coordination and for dealing with learning partners, both of which are essential brokerage activities at the implementation stage.

Finally, the CEO of the Educational Council and the director of KnowledgeWorks again have good brokerage positions, just as in the planning stage, since their normalized betweenness scores are 13.04 and 7.79 respectively.

In sum, it can be concluded that betweenness tended to increase as the Metro network evolved. This has several implications for structural development. First, the increase of betweenness indicates that a network becomes less stable and more vulnerable due to the presence of high brokerage persons/groups/organizations connecting different organizations. If such a liaison person, group or organization is eliminated from the network, it may lead to the disconnection of subnetworks that are not connected directly. This is consistent and therefore preliminarily confirms Hypothesis 6 about public management networks becoming less balanced and stable over time. Secondly, the increase in network betweenness serves as an indicator of the flow of resources such as information, money and other resources. Kapucu (2009) already found that low scores in
betweenness centrality indicate the low communication dependency of network actors on other organizations. Therefore, high scores in betweenness can be indirectly associated with an increased flow of resources, which confirms Hypothesis 5, stating that as public management networks develop over time, the flow of resources in the network increases. When it comes to the individual scores of betweenness, the results shown in Table 6.8 suggest that members of the Metro Partnership Group tend to hold high brokerage positions in both stages of development. However, “betweenness leaders” tend to change depending on the stage. For example, political or strategic positions such as CEO or president are more prevalent at the planning stage, whereas the implementation stage is characterized by the brokerage of tactical managers such as the vice president and project manager of Battelle, the Metro High School principal, and teachers organizing the learning experiences through various learning partners. Finally, the increase of betweenness over time suggests that the bridging of structural holes also increases over time, which confirms Hypothesis 7 on a preliminary basis. As a network evolves, some entrepreneurial network actors take advantage of the unconnected parts of the network by linking different actors with untapped resources. This is true in the case of Metro High School. Many learning partners and learning sites joined the Metro network at the implementation stage.

**Effect of individual characteristics of network actors on density**

Structural hypotheses based on theories of homophily suggest that the probability that a network actor will have a connection with another network actor depends on the similarity of their demographic and organizational characteristics such as age, gender,
social status, education, professional affiliation, organizational affiliation, sector affiliation, prestige and many others (Carley, 1991; Coleman, 1957; Contractor et al., 2006; Ibarra, 1992, 1993, 1995, 1997; Laumann, 1966; Marsden, 1988; McPherson et al., 2001). Here I present the results of exploratory social network analysis to investigate the relationship between exogenous variables such as gender, sector affiliation and interorganizational network experience, and the subgroup density, which measures the difference in density of two or more groups, based on particular attributes of the network actor.

Table 6.9 shows subgroup density by gender in the Metro High School network at the pre-project, planning and implementation stages. The results of the analysis of subgroup density by gender indicate that males tend to exhibit homophily at all stages of network development, with the effect being stronger in the pre-project and planning stages. Females, on the other hand, send more ties to males in the pre-project and implementation stages (14.4%) than to their own group (0.29).

<table>
<thead>
<tr>
<th></th>
<th>Pre-Project Stage</th>
<th>Planning Stage</th>
<th>Implementation Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Female</td>
<td>0.029</td>
<td>0.144</td>
<td>0.029</td>
</tr>
<tr>
<td>Male</td>
<td>0.083</td>
<td>0.300</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Note: The subgroup density was calculated by the average method.

In the implementation stage, one can see changes in the homophily relations between males and females. Males still send more ties to males (26.7%) than to females (12.2%), but this proportion is quite different from the pre-project and planning stages,
where males tended to send four times more ties to males (30%) than to females (about 8%). Therefore, it can be concluded that gender segregation appears to be higher in the planning stage than in the implementation stage. Based on the this conclusion, I can confirm Hypothesis 8 on a tentative basis, postulating that as public management networks develop over time, gender separation tends to occur less.

The relationship between interorganizational network experience and subgroup density points to the importance of network experience in the early stages of network development. The results of this supporting analysis can be found in Table 6.10.

Table 6.10: Subgroup density by IONE in the Metro network at the different stages of development

<table>
<thead>
<tr>
<th>IONE</th>
<th>Pre-Project Stage</th>
<th>Planning Stage</th>
<th>Implementation Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No IONE</td>
<td>IONE</td>
<td>No IONE</td>
</tr>
<tr>
<td>No IONE</td>
<td>0.014</td>
<td>0.029</td>
<td>0</td>
</tr>
<tr>
<td>IONE</td>
<td>0.064</td>
<td>0.108</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Notes: The subgroup density was calculated by the average method.
IONE – interorganizational network experience

Respondents with high interorganizational network experience tend to send more ties within their own subgroup at pre-project and planning stages of the project. The most striking difference is observed at the planning stage where respondents with interorganizational network experience send ties to their group (20.8% of the total possible ties) and respondents without interorganizational network experience send few ties to the respondents with interorganizational network experience (2.3% of the total possible ties) and send no ties to their subgroup.

At the implementation stage, respondents without interorganizational experience still send somewhat higher amounts of ties to respondents with interorganizational
network experience (38.7% of the total possible ties) than to their own subgroup (34.4% of the total possible ties), but the difference is small. Meanwhile, the respondents with interorganizational network experience still send more ties to their own subgroup, but the difference in the density of ties between the two subgroups at the implementation stage is smaller compared to the planning stage (19.6% in the planning stage versus 11.4% in the implementation stage).

The presence of interorganizational network experience is crucial for developing network interactions at the early stages of network development since the governing network rules are established at this stage. Having compared the results of subgroup density by interorganizational network experience, one can conclude that interorganizational experience matters predominantly at the planning stage when the network actors have to activate different people and mobilize resources. Thus, confirmation of Hypothesis 9 is possible: as public management networks develop over time, interorganizational network experience has less of an effect on establishing relations.

Table 6.11 shows subgroup density by sector affiliation in the Metro High School network at the pre-project, planning and implementation stages. The results of the analysis of subgroup density by sector affiliation indicate that representatives of private organizations tend to exhibit a slight propensity to homophily in the planning stage and implementation stage. In the pre-project stage, the representatives of private sector organizations send slightly more ties to the representatives of the public sector (27.4% of the total possible ties) than to the respondents of the same sector (22.9% of the total possible ties). In the planning and implementation stages, the representatives of private
sector organizations consistently send more ties to same-sector organizations, with the effect being stronger in the planning stage.

Table 6.11: Subgroup density by sector affiliation in the Metro network at the different stages of development

<table>
<thead>
<tr>
<th></th>
<th>Pre-Project Stage</th>
<th>Planning Stage</th>
<th>Implementation Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private Public</td>
<td>Private Public</td>
<td>Private Public</td>
</tr>
<tr>
<td>Private</td>
<td>0.229 0.223</td>
<td>0.181 0.223</td>
<td>0.194 0.173</td>
</tr>
<tr>
<td>Public</td>
<td>0.274 0.270</td>
<td>0.129 0.073</td>
<td>0.164 0.173</td>
</tr>
</tbody>
</table>

Note: The subgroup density was calculated by the average method.

A different picture of relationships between subgroup density and sector affiliation is observed in the case of representatives of public sector organizations. Similar to the representatives of private sector organizations in the pre-project stage, the representatives of public sector organizations at the pre-project stage send more ties to the representatives of the private sector organizations (27% of the total possible ties) than to the respondents of the same sector (22% of the total possible ties). In the planning stage, the representatives of public sector organizations tend to be less homophilic by sending more ties to the representatives of private sector organizations (10% of the total possible ties) than to the representatives of the same sector organizations (7.3% of the total possible ties). However, the homophily orientation of the representatives of public sector organizations is restored in the implementation stage. In this stage, the representatives of public sector organizations again send more ties to the representatives of the private sector organizations (17.3% of the total possible ties) than to the respondents of the same sector (11.7% of the total possible ties). It can be reasonably
assumed that the planning stage requires more interactions among the organizations irrespective of their sectoral affiliation.

In sum, it can be concluded that the difference of sectoral affiliation is more important in the planning stage in the case of Metro High School, when the organizational representatives from the different sectors forge connections irrespective of the sector affiliation. As has been described in this case study, representatives from different organizations had to move beyond their comfort zones to design a new kind of high school. It appears that the implementation stage allowed organizations in the same sector to interact according to the routine practices that had been established before the network formation. Thus, Hypothesis 10, which postulates that as public management networks develop over time, sector dissimilarity has less effect on establishing relations in the network, can be confirmed on a provisional basis.

6.5 Final testing of structural hypotheses by exponential random graph modeling

As a form of confirmatory network analysis, exponential random graph modeling (ERGM), based on random graph models such as Markov random graph models (Frank & Strauss, 1986; D. Strauss & Ikeda, 1990) and the p* family of models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996), allows for the testing of different endogenous and exogenous variables as structural tendencies of observed networks, in this case, of the Metro High School network.
The exponential random graph model (ERGM) approach was used to test the structural hypothesis on the development of relationships in the planning and implementation stages of this STEM high school project. The statistical software PNet was used to test the hypothesis at the individual level. The results of ERGM for the planning and implementation networks are found in Tables 6.12 and 6.13.

Table 6.12 shows the tendency of the Metro network at the planning stage toward edges, reciprocity and activity spread (AoutS), while holding mixed-2-star, balanced triads, popularity spread (AinS), Alt-in-1-out-star (Ain1outS), Alt-in-alt-out-star (AinAoutS), path closure (AT-T), multiple localized connectivity (A2P-T) and A2P-TD parameters constant.

As for dyadic attributes, all parameters for gender, previous inter-organizational experience and sector affiliation are not statistically significant at 0.05 level. Based on the ERGM results, it can be concluded that network actors are less likely to form ties and increase of the density of the network. However, the relationships among network actors are more likely to be reciprocated (reciprocity = 1.54; s.d. = 0.74, t = -0.02, p < 0.05).

The positive and significant parameter for activity spread (Alt-out-star or AoutS) indicates that network actors holding the central positions are more likely to send connections to other members rather than to receive ties. It may be concluded that they are more likely to be disseminators of information, who are engaged in the processes of mobilizing and activating (Agranoff & McGuire, 2001b).

The results of testing structural hypotheses based on gender, interorganizational network experience and sector affiliation indicate that none of these exogenous variables has a statistical effect on the propensity of forming a tie. It can be seen from Table 6.12
Table 6.12: Results of ERGM for Metro network at the planning stage

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Parameter</th>
<th>Standard Error</th>
<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ark</td>
<td>-7.14432</td>
<td>1.04716</td>
<td>-0.02189</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.535074</td>
<td>0.74583</td>
<td>0.01977</td>
</tr>
<tr>
<td>Mixed-2-Star</td>
<td>-0.13115</td>
<td>0.07216</td>
<td>0.00696</td>
</tr>
<tr>
<td>300 triads</td>
<td>0.272346</td>
<td>0.25984</td>
<td>0.09232</td>
</tr>
<tr>
<td>Popularity spread Alt-in-star (AinS)</td>
<td>1.13068</td>
<td>0.7293</td>
<td>0.02375</td>
</tr>
<tr>
<td>Activity spread Alt-out-star (AoutS)</td>
<td>2.367259</td>
<td>0.85667</td>
<td>-0.00636</td>
</tr>
<tr>
<td>Alt-in-1-out-star (A1outS)</td>
<td>0.062529</td>
<td>0.36199</td>
<td>-0.00262</td>
</tr>
<tr>
<td>Alt-in-alt-out-star (AinAoutS)</td>
<td>1.428274</td>
<td>0.93324</td>
<td>-0.02604</td>
</tr>
<tr>
<td>Path closure (AT-T)</td>
<td>0.487302</td>
<td>0.26334</td>
<td>-0.01688</td>
</tr>
<tr>
<td>Multiple localized connectivity (A2P-T)</td>
<td>0.569217</td>
<td>0.47432</td>
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<tr>
<td>A2P-TD</td>
<td>-1.28503</td>
<td>0.70755</td>
<td>-0.0327</td>
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</table>

**Dyadic attributes**

<table>
<thead>
<tr>
<th></th>
<th>Parameter</th>
<th>Standard Error</th>
<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rb for Male:</td>
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<tr>
<td>Rb for IONE</td>
<td>-0.587276</td>
<td>0.64457</td>
<td>-0.03437</td>
</tr>
<tr>
<td>Rb for Public Sector</td>
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<td>0.65772</td>
<td>-0.00796</td>
</tr>
<tr>
<td>Rs for Male</td>
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<td>0.00505</td>
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<td>Rs for IONE</td>
<td>0.195035</td>
<td>0.49711</td>
<td>-0.0181</td>
</tr>
<tr>
<td>Rs for Public Sector</td>
<td>0.25825</td>
<td>0.42736</td>
<td>-0.01179</td>
</tr>
<tr>
<td>Rr for Male</td>
<td>0.097345</td>
<td>0.28621</td>
<td>-0.03066</td>
</tr>
<tr>
<td>Rr for IONE</td>
<td>0.493265</td>
<td>0.39233</td>
<td>-0.04319</td>
</tr>
<tr>
<td>Rr for Public Sector</td>
<td>0.468461</td>
<td>0.36476</td>
<td>0.00408</td>
</tr>
</tbody>
</table>

**Note:** IONE – interorganizational network
Significant average effect sizes at \( p < .05 \) are printed in bold.

- denotes actors with or without attributes.
that neither the gender nor the previous experience in interorganizational networks (IONE) of an individual actor, nor sector affiliation has any level of significant effect on the development of relationships in the planning stage.

More statistically significant structural parameters are found in the implementation network. Table 6.13 shows a tendency of the Metro network at the implementation stage toward arcs, alt-in-1-out-star (Ain1outS), alt-in-alt-out-star (AinAoutS), popularity spread (AinS), and path closure (AT-T), while holding reciprocity, 2-out-star, balanced triads, activity spread (AoutS), multiple localized connectivity (A2P-T) and A2P-TD parameters constant.

As for dyadic attributes, the Metro network at the implementation stage is no different from the Metro network at the planning stage according to the ERGM results. No parameters for gender, previous interorganizational experience and sector affiliation are statistically significant ($p < 0.05$). Based on the ERGM results, one can conclude that network actors are less likely to form ties and increase the density of the network ($\text{ark} = -6.78; \text{s.d.} = 1.59, t = 1.02, p < 0.05$). However, the relationships among network actors are not likely to be reciprocated, due to statistically insignificant results. The same picture is found for parameters modeling for two path (mixed-2-star) and balanced triads (300 triads) since their parameters are not statistically significant ($p < 0.05$).

The Metro network at the implementation stage appears to be centralized due to the presence of network actors who receive more ties from other network actors, but these actors send fewer ties than they receive (so called in-stars). The positive and statistically significant parameters for popularity spread (AoutS) and alt-in-alt-out-star.
Table 6.13: Results of ERGM for Metro network at the implementation stage

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Parameter</th>
<th>Standard Error</th>
<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Ark</td>
<td>-6.78711</td>
<td>1.59079</td>
</tr>
<tr>
<td></td>
<td>Reciprocity</td>
<td>0.916015</td>
<td>0.53728</td>
</tr>
<tr>
<td></td>
<td>Mixed-2-Star</td>
<td>0.039434</td>
<td>0.03604</td>
</tr>
<tr>
<td></td>
<td>300 triads</td>
<td>0.133329</td>
<td>0.38196</td>
</tr>
<tr>
<td></td>
<td>Popularity spread Alt-in-star (AinS)</td>
<td>1.851254</td>
<td>0.69296</td>
</tr>
<tr>
<td></td>
<td>Activity spread Alt-out-star (AoutS)</td>
<td>-0.16099</td>
<td>0.51555</td>
</tr>
<tr>
<td></td>
<td>Alt-in-1-out-star (Ain1outS)</td>
<td>-0.48479</td>
<td>0.22128</td>
</tr>
<tr>
<td></td>
<td>Alt-in-alt-out-star (AinAoutS)</td>
<td>2.258646</td>
<td>0.99727</td>
</tr>
<tr>
<td></td>
<td>Path closure (AT-T)</td>
<td>0.903491</td>
<td>0.21417</td>
</tr>
<tr>
<td></td>
<td>Multiple localized connectivity (A2P-T)</td>
<td>-0.2446</td>
<td>0.1394</td>
</tr>
<tr>
<td></td>
<td>A2P-TD</td>
<td>0.255619</td>
<td>0.19189</td>
</tr>
<tr>
<td>Dyadic attributes</td>
<td>Rb for male:</td>
<td>-0.22713</td>
<td>0.74382</td>
</tr>
<tr>
<td></td>
<td>Rb for IONE</td>
<td>-0.58728</td>
<td>0.64457</td>
</tr>
<tr>
<td></td>
<td>Rb for public sector</td>
<td>-0.91697</td>
<td>0.65772</td>
</tr>
<tr>
<td></td>
<td>Rs for male</td>
<td>-0.1112</td>
<td>0.36333</td>
</tr>
<tr>
<td></td>
<td>Rs for IONE</td>
<td>0.195035</td>
<td>0.49711</td>
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<td>Rs for public sector</td>
<td>0.25825</td>
<td>0.42736</td>
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<td>Rr for male</td>
<td>0.097345</td>
<td>0.28621</td>
</tr>
<tr>
<td></td>
<td>Rr for IONE</td>
<td>0.493265</td>
<td>0.39233</td>
</tr>
<tr>
<td></td>
<td>Rr for public sector</td>
<td>0.468461</td>
<td>0.36476</td>
</tr>
</tbody>
</table>

**Note:** IONE – inter-organizational network
Significant average effect sizes at \( p < .05 \) are printed in bold
- denotes actors without attributes.
(AinAoutS) configurations as well as the negative and statistically significant parameter for alt-in-1-out-star (Ain1outS) indicate that public network management networks tend to be centralized in the implementation stage. The results of ERGM in Table 6.13 also suggest that public management networks tend to exhibit signs of hierarchy at the implementation stage. AT-T configuration, or path closure (Robins et al., 2008), was included in the ERGM models to test the structural hypothesis about transitivity, since it is a higher order network configuration used for highly dense networks with elements of transitivity (Snijders et al., 2006).

The parameter for a path closure (AT-T) network configuration is statistically significant ($\beta_{AT-T} = -0.90; \text{s.d.} = 0.21, t = 0.02, p < 0.05$). Therefore, it can be concluded that public management networks tend to gravitate toward hierarchy at the implementation stage.

Table 6.14 presents a summary of results for testing hypotheses of the structural development of public management networks over time. All hypotheses that could be tested by means of exploratory network analysis were tentatively confirmed. Hypothesis 3b, 4 and 5 could be not tested by means of exploratory social network analysis but were instead tested by triadic census analysis (Wasserman & Faust, 1994) using the computer software PNet (Wang et al., 2009). Two of the three structural hypotheses tested by triadic census analysis were confirmed: Hypotheses 3b, regarding diminishing hierarchy, and Hypothesis 5, regarding the decreased stability and balance of public management networks over time.

Hypothesis 4, suggesting an increase in the flow of resources over time, was not confirmed by the results of the triadic census analysis. The network at both the planning
and implementation stages happened to be an acyclical network (Nooy et al., 2005), meaning that it had no 030 cyclical triads at all.

### Table 6.14: Summary of Testing Structural Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Exploratory Network Analysis</th>
<th>Confirmatory Network Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1: As public management networks develop over time, they tend to become more centralized</td>
<td>Confirmed</td>
<td>Confirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 2: As public management networks develop over time, network density tends to increase</td>
<td>Confirmed</td>
<td>Disconfirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 3: As public management networks develop over time, they tend to become less hierarchical (transitivity 3a and transitive triads 3b)</td>
<td>Confirmed-3a</td>
<td>Confirmed-3b (p*models)</td>
</tr>
<tr>
<td>Hypothesis 4: As public management networks develop over time, the flow of resources in the network increases (more cyclical triads tend to occur)</td>
<td>N/A</td>
<td>Disconfirmed (triadic census) Not modeled in p* models</td>
</tr>
<tr>
<td>Hypothesis 5: As public management networks develop over time, they tend to be less balanced and stable (fewer fully reciprocated triads tend to occur)</td>
<td>N/A</td>
<td>Confirmed (triadic census) Disconfirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 6: As public management networks develop over time, reciprocity of ties tends to decrease</td>
<td>Confirmed</td>
<td>Confirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 7: As public management networks develop over time, bridging tends to increase</td>
<td>Confirmed</td>
<td>Confirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 8: As public management networks develop over time, gender similarity has less effect on the propensity to form ties.</td>
<td>Confirmed</td>
<td>Disconfirmed (p*models)</td>
</tr>
<tr>
<td>Hypothesis 9: As public management networks develop over time, interorganizational network experience has less effect on establishing relations</td>
<td>Confirmed</td>
<td>Disconfirmed (p* models)</td>
</tr>
<tr>
<td>Hypothesis 10: As public management networks develop over time, sector similarity has less of an effect on establishing relations in the network</td>
<td>Confirmed</td>
<td>Disconfirmed (p* models)</td>
</tr>
</tbody>
</table>
Therefore, it was decided to remove the cyclical triads from further modeling, p* modeling in particular. As a result, only nine structural hypotheses were entered into p* models. The absence of cyclical triads has theoretical implications for the structural development of networks. Some authors, such as Bearman (1997), suggest that cyclical triads play a vital role in social systems, but in as much as the principle of general exchange is overridden by direct reciprocity, this makes the cyclical pattern of resource exchange more or less worthless as an object of study in interorganizational networks (Rank et al., 2010).

Only three out of nine structural hypotheses were confirmed by the results of p* models (Anderson et al., 1999; Pattison & Robins, 2002; Pattison & Wasserman, 1999; Robins et al., 2001; Wasserman & Pattison, 1996). Positive and statistically significant parameters for out-degree network configuration ($A_{out}S = 2.36; \text{s.d.} = 0.86, t = -0.006, p < 0.05$) in the planning stage and positive and statistically significant parameters for popularity spread ($A_{out}S$), alt-in-1-out-star ($A_{in1out}S$) and alt-in-alt-out-star ($A_{inAout}S$) configurations in the implementation stage suggest that public management networks become centralized over the course of network development. Hypothesis 1 was confirmed. This is consistent with the findings of the Contractor et al. (2006) study on the CRADA interorganizational network at the implementation stage, who found that interorganizational networks tend to gravitate towards “a centralized overall network” (p. 700).

Hypothesis 6, stating that reciprocity in public management networks decreases over time, was confirmed. This conclusion was made based on the comparison of results of testing reciprocity at both stages. At the planning stage, the parameter for reciprocity is
positive and statistically significant (reciprocity = 1.54; s.d. = 0.74, t = -0.02, p < 0.05), whereas at the implementation stage, it is positive but not statistically significant (p < 0.05). Therefore, reciprocity is important at the planning stage, since network members are engaged in the processes of mobilizing different resources and actors and setting rules, norms and values for effective functioning of the network in the future. At the implementation stage, however, the number of mutual ties decreases since strategic actions are developed and trust is developed.

Hypothesis 7, stating that over the course of network development an increase of bridging among the network actors would occur, was confirmed as well. The statistically insignificant parameter for a path closure (AT-T) network configuration at the planning stage and the positive but statistically significant parameter for path closure (AT = 0.90; s.d. = 0.21; t = 0.018; p < 0.05) at the implementation stage suggest that the bridging of network actors increases as the network develops over time. Bridging the structural holes in the later stages of development is necessary for tapping the diverse network actors with resources who are not yet connected to the network. In this way, the network leaders or network champions exploit the resources, knowledge and innovations of network actors who currently have no connections in the network.

The structural hypothesis modeling the network density was disconfirmed based on the results of p* models. Hypothesis 2, suggesting an increase of density over the course of network development was disconfirmed. The parameter for ark was negative but statistically significant both at the planning stage (ark = -7.14, s.d. = 1.04, t = -0.02, p < 0.05) and implementation stage (ark = -6.78, s.d. = 1.59, t = 0.01, p < 0.05). This is a surprising result that can be interpreted in the opposite direction of Hypothesis 2. It
appears, based on the results of p* models, that as a public management network develops over time, it has less propensity to have a higher density. This can be explained by the concentration of ties around the main network, which subsequently leads to the increased centralization of the leading network actors at the implementation stage.

The structural hypotheses modeling two types of triads related to balance theory (Heider, 1958; Holland & Leinhardt, 1975, 1981) were disconfirmed as well, based on the results of p* models. Hypothesis 3, proposing the decrease in hierarchy of public management networks over the course of development was not confirmed. At the planning stage, the parameter for path closure, a higher order configuration recommended for inclusion into the models of a high density network with elements of transitivity, was found to be negative but statistically insignificant. Meanwhile, the p* model for the Metro school at the implementation stage yields a positive and statistically significant parameter for path closure (AT-T = 0.90; s.d. = 0.21, t = 0.018, p < 0.05). This completely contradicts Hypothesis 3. The results of p* models suggest that, in fact, public management networks become more hierarchical as a network develops over time. This is consistent with the findings of the Contractor et al. (2006) study on the CRADA interorganizational network at the implementation stage, which found that actors in the network at the implementation stage were inclined to form transitive triads rather work in reciprocated dyads.

Hypothesis 5, proposing that as public management networks develop over time that networks tend to be less balanced and stable, was not confirmed either. It was expected that there would be fewer balanced triads (300 type) at the implementation stage than at the planning stage. However, parameters for balanced triads both at the planning
and implementation stages are found to be positive, though statistically insignificant. It may be reasonably concluded that the balance and stability of the network may be modeled by other network configurations, perhaps by other higher order configurations such as A2P-T, A2P-D, A2P-T or A2P-TDU. Research on these higher order configurations continues and brings to life new ways of employing these configurations in organizational and interorganizational research (Robins et al., 2008; Snijders et al., 2006).

Structural hypotheses that modeled exogenous variables based on gender, interorganizational network experience and sector similarity were all disconfirmed. Parameters for each of these exogenous variables were negative but statistically insignificant for both planning and implementation networks. Therefore, I can conclude that neither the gender, the previous experience in interorganizational networks (IONE), nor the sector affiliation of an individual actor had significant effect on the propensity to form a tie either at the planning stage or implementation stage. One possible explanation may be that the parameter for forming a tie was negative but statistically significant at both stages of network development.

Given the fact that other endogenous variables such as centralization, reciprocity and path closure had statistically significant parameters, it is expedient to test various structural hypotheses based on such measures as differential reciprocation, differential transitivity and differential centralization (Contractor et al., 2006) for the individual attributes of the network actors. For example, it can be hypothesized that males tend to hold more central positions in the planning stage than in the implementation stage (differential network centralization by gender). This hypothesis was derived from the
Ibarra (1992) study, which suggests that, compared to women, men tend to hold more central positions across expressive and instrumental networks as well as gain more benefits from homophilous relationships and individual and positional resources. Similarly, one can reasonably assume that representatives from the public sector are more likely to be central in the planning stage than at the implementation stage (differential network centralization by sector affiliation). This structural hypothesis is made based on the application of collective action theory (Coleman, 1973, 1990) in the Contractor et al. (2006) study about the CRADA research project, an interorganizational network consisting of three US agencies and private sector organizations. They found that government network actors in the interorganizational network were less likely to form a tie with other network actors representing government organizations, and so did not contribute to centralization among the representatives of government organizations.

The number of structural hypotheses based on shared characteristics can be considered at the dyadic level using the idea of differential reciprocity (Contractor et al., 2006). Using the results of analysis on the subgroup density by interorganizational experience, it can be also hypothesized that network actors with interorganizational experience are more likely to have reciprocal relations at the planning stage than at the implementation stage since they have first-hand knowledge as to how to initiate the working relationships in interorganizational-network settings. Similarly, Contractor et al. (2006) suggest that representatives from the same sector are likely to have more reciprocal relationships in the planning stage than in the implementation stage. This hypothesis can be theoretically linked to resource dependency theory (Pfeffer & Salancik, 2003) and the theory of generalized exchange (Blau, 1964; Homans, 1974). Theories of
homophily (Coleman, 1957; Ibarra, 1992, 1993, 1995, 1997) can predict reciprocity in the relationships between men and women in interorganizational networks. One can reasonably assume that men are more likely to have reciprocal relationships with each other in the planning stage rather than in the implementation stage, when relationships between men and women become less homophilous. Therefore, it can be assumed that dense subnetworks among men tend to disappear in the course of network development.

Similarly, the structural hypotheses based on shared characteristics can be considered at the triadic level using the idea of differential transitivity (Contractor et al., 2006). For example, Contractor et al. (2006) in their study on the CRADA interorganizational network at the implementation stage found that network actors representing the government organizations were not more likely to form transitive triads with each other than with representatives of private organizations. It can then be hypothesized that representatives from public organizations are more likely to form transitive triads at the planning stage than at the implementation stage. At the planning stage, representatives of public organizations are more inclined to form transitive triads as a sign of the hierarchical heritage of a bureaucratic past. At the implementation stage, the representatives of public organizations would not be more likely to form transitive triads with the government sector than with representatives of the private sector. In fact, this would indicate the presence of collaboration across sectors (Contractor et al., 2006).
Summary

This chapter provides the detailed results of hypotheses explaining the structural development of public management networks over time, which were outlined in Chapter 3. First, I presented the results of exploratory network analysis to highlight the structural properties of the Metro school network at each stage of development to test the structural hypotheses at the global, dyadic and individual levels of the network. As a result of the exploratory network analysis research, all ten hypotheses of the structural development of public management networks over time were confirmed in a preliminary way. The results of confirmatory network analyses refined the results obtained from the exploratory analysis. Some of the hypotheses related to balance theory were confirmed by triadic census analysis but ultimately rejected by p* models. At the end of testing, only the three structural hypotheses based on reciprocity, structural autonomy and network centrality were confirmed. The results of p* modeling point at the possibility of employing higher order network configuration for future research. In addition, several structural hypotheses for individual actor attributes were suggested for testing in future studies, which are based on such measures as differential reciprocation, differential transitivity and differential centralization (Contractor et al., 2006).
CHAPTER 7: CONCLUSION AND DISCUSSIONS

This study develops a framework of structural tendencies in public management network organizations using a multitheoretical, multilevel approach (Contractor et al., 2006) with a dynamic perspective. It suggests propositions about the structural configurations of public management networks in the different stages of network development. Then, it tests those suggested propositions. Thus, this study answers the following questions that are both practically and theoretically important at the theoretical level: What processes are predominant for each stage in the evolution of public management networks? What are the structural configurations of public management networks in the different stages of network development at different levels of the network (actor, dyadic, triadic and global level)? What is the effect of the individual characteristics of the network actors, such as gender, sector affiliation and inter-organizational network experience, on the structural configurations of public management networks over time?

This chapter focuses primarily on a discussion of the conclusions and implications of the research findings. I review the main analytical findings of the Metro High School case as well as the results of testing my model of the structural aspects of the development of public management networks. Based on the research findings, I provide some guidelines for public program evaluators as to how to use this kind of modeling to assess the effectiveness of public management networks. The limitations and implications for future research are discussed at the end.
7.1 Review of Key Findings

The case of Metro High School appears to support the important tenets of a theoretical framework for the structural development of public management networks over time. It shows how different sociological, organizational and public management theories can be applied at the different network levels (actor, dyad, triad and global level) to understand the time-oriented structural development of a public management network. The framework for structural development over time presented here can undoubtedly be applied to assess and evaluate the process of development of other public management networks. As such, this study contributes to the body of public management network literature by identifying structural configurations at the various stages of network development using different levels of analysis. By different levels, I mean the level of the whole network (global level), the dyadic level, the triadic level and the individual network actor level (i.e., an organization or individual representing an organization in the network). This study attempted to look into the structural dimensions of network evolution in order to facilitate the development of network theory and to develop practical recommendations for public managers embarking on the critical path of the “network manager.” Below are the key findings of the Metro High School case study as well as the results of testing my model of the structural aspects of the development of public management networks.

First, this study provides empirical support for the model of network behaviors developed by Agranoff and McGuire (2001b) that includes activating, framing, mobilizing and synthesizing. The grounded theory study of the Metro High School network suggests that this model of network behaviors can be used for explaining the
development of public management networks that can be identified as goal-directed networks (Kilduff & Tsai, 2003). Similar to network behaviors, the processes predominantly leading to the formation of networks includes the identification of key individuals, identification of key resources, mobilizing activities, setting norms, rules and values, and developing and building trust. Identification of key individuals is a necessary process for the development and maintenance of a public management network by providing vision, guidance and leadership along with the necessary financial, informational, and human resources and expertise. Identification of key resources allows for the procurement of these necessary requisites to initiate the development of a public management network and to ensure the network’s sustainability. Mobilization as a network development process ensures the external and internal support for a public management network especially in fragile development stages when these public management networks are unstable and in great need of the support of various constituencies. It includes mobilizing organizations (Mossberger & Hale, 1999, September), mobilizing coalitions (Kickert & Koppenjan, 1997), mobilizing communities, reaching agreement regarding the role of an organization and the scope of work within the network’s functioning (Benson, 1975) and, finally, ensuring the support of interacting organizations (Agranoff & McGuire, 2001b). The setting of norms, rules and values allows for effective and efficient interactions among the network actors in a public management network. Building and development of trust is closely connected to all other processes of network development and relies heavily on institutional, personal and social linkages that solidify the working relationships among the network participants.
In this investigation, all five of these network processes were identified both at the planning and implementation stages. However, the intensity and level at which these processes took place are quite different. The network processes at the planning stage were carried out at the strategic level, but the same network development processes at the implementation stage were observed to have a more tactical and operational character. Identification of key persons included both inclusion of operational partners and the exclusion of strategic partners who had already performed their primary role during the planning stage and are not really necessary during the implementation stage. Mobilizing practices in the implementation stage were also aimed at the involvement of different audiences into the operational life of the Metro school as well as at fine-tuning the relationship between various stakeholders who were directly or indirectly participating in the governing of the network. Similarly, setting rules, norms and values contributed mainly to the development of administrative and management control systems. Along these lines, the level of building and developing trust among network participants at the implementation stage shifted from the top executives in the Metro network to those who worked at its operational core and in the school districts.

Second, this study emphasizes the importance of network managers and their goal-setting role in network development. The results of the grounded theory study and exploratory network analysis point to the engagement of network leaders and champions in the process of setting norms, rules and values that is called “framing” (Agranoff & McGuire, 2001b). Development of norms, rules and values can be singled out as one of the most important development processes for the evolution of public management networks engaged in addressing “wicked policy” problems (Rittel & Webber, 1973). The
chances of a public management network being developed by serendipitous network processes are very rare, since network leaders and champions pursue shared goals (Kilduff & Tsai, 2003) that are compatible with their home organizational goals, missions, mandates and philosophes. These shared goals are usually negotiated at the initial meetings of network founders, like the Tacoma meeting in the case of Metro. These shared goals provide a firm foundation for rapid network development. It is also necessary to note that these shared goals are not written in stone but rather subject to change, depending on the stage of network development. The analysis of network development processes at the different stages shows that some of the network goals at the planning stage were abandoned; some of them were renegotiated or replaced with new ones to address the current challenges of internal network structuring and the constraints posed by the external environment. The change of network goals in public management networks over time, as in the case of Metro High School, suggests that the evolution of public management networks can be best explained by teleological theories of organizational change (Van de Ven & Poole, 1995) rather than by evolutionary theories of change such as population ecology (Hannan & Freeman, 1977).

Third, this study shows that the emergence and presence of governing and managing structures determine the structure and operation of public management networks. More specifically, the results of exploratory social network analysis (Nooy et al., 2005) and the grounded-theory study of Metro suggests that the emergence and presence of governing structures such as the Metro Partnership Group and the Educational Council determine the social structuring of public management networks over time. The prevalence of governing structures at the planning stage make public
management networks more hierarchical but less centralized, to ensure the strategic development and coordination of public management networks in an efficient and democratic manner. In Human and Provan’s business study (2000) they call these structures “network brokers” or “network administrative organizations” and believe that these are designed to “help build the network, coordinate and manage its activities, support network firms and network-level goals, and provide a centralized location for performing key activities of the network” (p. 330). However, these governing structures do not just disappear at the implementation stage. On the contrary, they become more hierarchical and exhibit the characteristics of organizational hierarchies or vertical structures. At the implementation stage, governing structures or subnetworks are also complemented by managing structures such as the Metro Partnership group (which is simultaneously a governing and managing structure) and a subnetwork consisting of the Metro School principal and the staff of Metro High School.

Fourth, the multioriented theoretical framework of this study, which clearly explains the structural development of public management networks over time at different network levels, is developed and tested. This theoretical framework was developed based on the analytical framework of Contractor, Wasserman, and Faust (2006) and uses a multitheoretical, multilevel modeling approach to formulate a methodological guide to develop a theory regarding the structural development of public management networks. The application of multitheoretical, multilevel modeling to structural development shows that this analytical framework can be successfully used for modeling such structural configurations.
Fifth, this study concludes that centrality plays an important role in structuring public management networks. The principal of Metro holds the central position in the network at both the planning and implementation stages. Twenty five respondents who are currently involved in the Metro High School project nominated the principal of Metro in their working relations. However, the central position of the Metro school principal does not make this person an authoritarian decision maker. Other actors central to the network include top managers of Battelle Memorial Institute and KnowledgeWorks, members of the Metro Partnership Group, members of the Educational Council and the participating deans at Ohio State University. It has been statistically confirmed that the centrality of public management networks tends to increase as they evolve over time. The lower centralization at the planning stage suggests the equal interconnectedness of network members, who are able to engage in mobilizing activities (Laumann et al., 1985; Laumann & Pappi, 1976) and promote the collective good (Marwell & Oliver, 1993; Marwell, Oliver, & Prahl, 1988). Lower scores in centralization at the planning stage also indicate that network actors do not have enough control or influence over the network (DeLeon & Varda, 2009) to make strategic decisions. By contrast, the implementation stage is characterized by a high degree of centralization, which facilitates the integration of all operational activities (Provan & Milward, 1995) and strengthens collaboration activities among the network actors (Provan, Isett, et al., 2004).

Sixth, this study shows that network hierarchy varies depending on the stage of development. It is clear, based on the results of triadic census analysis, that the Metro planning network has a greater tendency toward hierarchy than does the implementation network. This suggests that network-level planning requires a central focus led by a few
champions even in the midst of many linkages. This proved to be the case in the initial meeting in Tacoma. This conclusion about the hierarchical features of public management networks at the planning stage dispels the myth about public management networks of being flat, where every network member enjoys the same rights and powers within the domain of the network. Public management networks are indeed “hilly” social terrains that include aspects of hierarchy (Rethemeyer & Hatmaker, 2008, p. 636), especially at the planning stage, a hierarchy where the scalar vector of power is clear, with distinct power differentials among network members and a distribution of power that follows the principles of hierarchical and managerial accountability. The implementation-network measures from the triadic census analysis confirm what we have known about program implementation in general: hierarchy, while present, is rarely the driving factor in an implementation network (Agranoff & McGuire, 2001b). Perhaps the successful planning and design of a program lends itself more to decentralized implementation since all the actors in the network have specific responsibilities for which they are held accountable. During the implementation stage, the power differentials among the network members are leveled off since the power in the network is shared by governing and managing structures: one governing structure is responsible for “managing across” networks and another managing structure responsible for “managing within” networks (Perri, 2006).

Seventh, this study found that reciprocity of relationships is an excellent indicator for measuring the development of trust, mutual support and the exchange of resources among the network participants at the different stages of network development. Collaborative activities are impossible without direct or reciprocated exchanges of
resources, especially financial, informational, and knowledge resources. High reciprocity is observed at the planning stage, since the network members are engaged in the process of setting rules, norms and values for effective future functioning. Or as Rank et al. (2010) conclude, “The strong preference for the formation of mutual exchange relationships among pairs of actors suggests that within the strategic decision process reciprocity norms have developed among participants that govern the level of mutual contributions and benefits of actors” (p. 758). At the implementation stage, however, the number of mutual ties decreases, since strategic decisions have already been made and trust has been developed. This is consistent with the findings of the Isett and Provan (2005) study of networks of publicly funded health and human services agencies, suggesting that trust (characterized by the level of reciprocity) does not increase over the course of public management network development. In fact, the implementation stage is characterized by indirect generalized exchange (Bearman, 1997; Yamagishi & Cook, 1993) where “each participant provides benefits to an actor in the network who does not return benefits directly to that participant” (Yamagishi & Cook, 1993, p. 237). This decrease of reciprocity over the course of the development of public management networks was also confirmed by the statistically significant results of p* models.

Eighth, this study found that the structural autonomy of a network actor is an excellent indicator for understanding the degree of utilization of diverse resources in public management networks over time. At the planning stage, network champions targeted the most popular actors in the network from a centrality point of view through the process of identifying key actors, which led to low structural autonomy and subsequently to a low level of bridging. At this point in network development, in order to
pursue the purposes of mobilizing and activating (Agranoff & McGuire, 2001b), network actors with many linkages would be the most beneficial to target. These actors maintain more relations with the various network actors and are capable of mobilizing human, informational, political and material resources when they are needed. At the implementation stage, network leaders or network champions start exploiting the resources, knowledge, and expertise of the network actors who currently have no connections in the network, thus increasing the process of bridging structural holes, which accompany the process of mobilizing (Agranoff & McGuire, 2001b). By bridging more structural holes at the implementation stage, the leaders or network champions take structural advantage by gaining access to the coveted information, untapped organizational resources and unutilized expertise of previously unconnected actors. The increase of bridging structural holes over time was confirmed by the statistically significant results of p* models.

Finally, this study shows that neither the gender, the previous experience in interorganizational networks (IONE), nor the sector affiliation of an individual actor had a significant effect on forming working relationships either at the planning or implementation stage. It appears that sector affiliation has no effect on forming a tie at any stage of network development, since formation, development and maintenance of public management networks requires collaboration across the sectors irrespective of the stage of development. Public, nonprofit and private organizations are supposed to go beyond the established routines of collaboration and within-sector preference in order to gain the benefits of cross-sectoral collaboration, characterized by lower transaction costs and greater diversity of resources from organizations from different sectors. Similarly,
the absence of a gender effect on the formation of working relationships at the planning and implementation stages may point to a leveling of power differentials among men and women. By its nature, public management networks not only contribute to the public policy goals of efficiency and effectiveness, but they also promote other public policy goals such as equity, gender equality and liberty. Finally, the fact that interorganizational network experience has no effect on the formation of a tie at any stage of development can be understood by considering the learning nature of the network. Public management networks can best be defined as a combination of a laboratory of democracy and a learning organization (Senge, 1990), "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (p. 3). Perhaps the interorganizational network experience has indeed no effect on the structuring of public management networks, but they are by default the training grounds where network actors learn how to collaborate with one another, learn about their own and their partners’ skills and, finally, learn each other’s goals (Doz, 1996). Even though we find no effect from any of these three exogenous variables (gender, interorganizational network experience and sector affiliation) on the probability of forming a connection or tie in any stage of network development, it is important to explore more complicated structural hypotheses based on exogenous variables. Given the fact that other endogenous variables such as centralization, reciprocity and path closure had statistically significant parameters, it is highly recommended the structural hypotheses be further tested based on such measures as
differential reciprocation, differential transitivity and differential centralization (Contractor et al., 2006).

7.2 Recommendations for public management practitioners

The present study provides some valuable recommendations for policy makers, public managers and public program evaluators who evaluate the effectiveness of networks that are a response to the complex and “wicked” problems (Rittel & Webber, 1973). Below is a set of the proposed recommendations.

First, one can strongly recommend utilizing the conceptual and methodological framework on the structural configurations of public management networks in the various stages of development. It can be used by policy analysts and public program evaluators to understand, measure, and evaluate the main aspects of network effectiveness using statistically robust approaches in network modeling.

Second, the model of network behaviors developed by Agranoff and McGuire (2001b) should be used in assessing the progress of network development in public management networks. All the network processes such as activating, framing, mobilizing and trust building have to be closely observed and monitored to understand the dynamics of network development at each stage. It is also recommended to use some of the structural characteristics such as density, reciprocity, degree centrality, betweenness and transitivity for assessing the development of public management networks. For example, outdegree centrality may show the degree of involvement in the process of identifying the key actors at the planning stage. Or the structural autonomy of a network actor, measured by betweenness (Wasserman & Faust, 1994), can assess the degree of mobilizing the
network actors who have untapped resources such as information, knowledge, expertise, finance, space and others.

Third, special attention should be paid to the hierarchy of the network at the different stages of development. Network-level planning necessitates a few network champions to be positioned hierarchically in order to ensure the proper formation of a network. The hierarchical position of these leading network actors is also important from the perspective of setting rules, norms and values. The implementation stage, however, diminishes the role of hierarchy because of the specific division of labor among network participants. Public managers should not be afraid of the presence of hierarchy in the beginning, as it appears to be a natural property of public management networks in the early stages of development.

Fourth, reciprocity should be used as an indicator that shows how trust, mutual support and exchange of resources among network participants is developed at the different stages of development. Increased reciprocity at the planning stage indicates the development of strategic norms that will govern the behavior of network participants at the later stages of development. The decrease of reciprocity at the implementation stage indicates that strategic actions have been taken, trust has developed, and network participants are more likely to be engaged in generalized exchange (Rank et al., 2010).

7.3 Limitations

This study contains notable limitations despite the fact that it represents a methodological shift from studying public management networks in descriptive terms to
making predictions of structural tendencies. First of all, this study investigates a single case of a cross-sectoral network of organizational entities, formed to establish a high school in line with the new STEM (Science, Technology, Engineering and Math) policy in Ohio. This means that the findings of the present study may have limited application for other public management networks. Nevertheless, the Metro school represents a typical case of cross-sectoral collaboration, and the interorganizational network emerged as a result of efforts by network leaders and champions. It has features that are common to many public management networks. Moreover, the Metro network is a case of a formal action network with a collection of informal relationships at the individual level that transcend organizational, governmental, and sectoral boundaries. Therefore, it is possible that the findings of this study cannot be fully applicable to other types of public management networks such as informational networks, developmental networks and outreach networks. Informational networks, for example, are not designed to directly deal with “wicked” policy problems (Rittel & Webber, 1973) or take particular actions to alleviate them. Instead, informational networks are aimed at exchanging information and learning about these problems as well as about various experiences. (Agranoff, 2007). It is other agencies that have the authority to tackle these problems. Metro, on the other hand, is capable of direct action and has a different role.

Meanwhile, the application of multitheoretical, multilevel modeling based on p* family models allows one to determine the structural tendencies of various types of public management networks using different sociological and organizational science theories. These approaches, not heretofore used in public management research, are recommended for exploring the structural tendencies of all types of public management
networks, including information, developmental, outreach, and action networks. Particular combinations of social and organizational theories can assist in explaining the social structure of public management networks. For example, theories of exchange (Bearman, 1997; Yamagishi & Cook, 1993) and cognitive theories of social networks (Kogut, 2000; Powell et al., 1996) can be used to understand and model the structural tendencies of information public management networks. Similarly, public management scholars can employ contagion theories (Burt, 1982; Fulk, Schmitz, & Steinfield, 1990; Marsden & Friedkin, 1993; Pfeffer & Salancik, 2003; Trevino, Lengel, & Daft, 1987) and theories of exchange (Bearman, 1997; Yamagishi & Cook, 1993) for studying the social structuring of outreach public management networks.

Second, strictly speaking this study cannot be considered to be a true longitudinal study, since the data were not collected at two points in time. The data for the first wave (planning stage) were reconstructed based on semi-structured interviews, which usually provide reliable data for identifying network relations in the past and are not characterized by significant recall error (Wright & Pescosolido, 2002). The data for the second wave (implementation stage) were derived from social-network surveys and, to ensure the reliability of the data, were triangulated with responses from the semi-structured interviews to questions about the implementation stage. To some extent, this study can be considered a cross-sectional study, where data are collected at one point in time and some data (data for the planning stage) were reconstructed from the interviews. Therefore, with regard to the temporal dimensions, the findings should be treated with caution when it comes to causality. It is also worth noting that collecting real longitudinal data from public management networks is still problematic for public policy analysts and
public administration scholars due to the likelihood of declining response rates (Provan et al., 2009) and in many cases of fluidity in network participants.

Third, the design of this study is based on analyzing only one network representing only one case of implementing a STEM initiative over two periods of time. Despite its innovative combination of longitudinal study and confirmatory network analysis (Contractor et al., 2006), it is still a study of one public management network. Clearly, the present study would have greater research value if it had been conducted on several networks at several points in time. This kind of research, however, would take more time and effort on the part of the researchers involved in the data collection. Therefore, it would be more realistic to have researchers test the proposed theoretical framework of structural signatures at different stages of network development against the various types of public management networks. It is also strongly recommended that researchers look at the relationships among various network actors for things such as information exchange, financial exchange, planning, and negotiating.

7.4 Implications for Future Research

This study has several theoretical and methodical implications that can provide guidance to public management scholars in future research on public management networks.

First, more research is needed on organizational forms such as the Metro High School network. Metro is an organizational structure operated by a network that develops and implements its own decisions. It is both a formal, networked structure and a collection of informal relationships at the individual level that transcend organizational,
governmental, and sectoral boundaries. However, it is far from a traditional public organization, characterized by high specialization, high formalization and high centralization. Even though it is characterized by some hierarchy in the governing core, the fundamental principles of Metro school are cooperation, consensus building, feedback, decentralization and participation of all network participants in the various operational and developmental processes. Metro school can truly be classified as an “organization 2.0,” a term coined by Agranoff (2012). An organization 2.0 is a networked organizational structure combining diverse network partners who are connected by various relationships in order to solve “wicked problems” (Rittel & Webber, 1973) such as poverty, environmental pollution, local economic development, the spread of sexually transmitted diseases, inadequate preparedness of high school students in math and the natural sciences, and many others. Although it was predicted that these new organizational forms (i.e., organization 2.0 will replace traditional bureaucratic organizations in the future (Milward & Provan, 2003), these forecasts are very unlikely. Meanwhile, it is critical for public management scholars to study these networked organizations because the latter are an integral part of the governance scenery nowadays in public administration. It is necessary to continue studying the structural and process aspects of organizations 2.0 as well as their impact on the performance of public management networks. The knowledge gained from these studies can be used to guide representatives from traditional bureaucratic organizations in their interactions with networked organizations to ensure overall network effectiveness and efficiency.

Second, more research is needed to understand the differences between traditional bureaucratic organizations and networked organizations like Metro High School in terms
of governance and hierarchy. Public managers have to learn how to switch from operating in the traditional vertical hierarchies to operating in the horizontal hierarchies of public management networks (Agranoff, 2012). The results of this study challenge the false belief held by some public managers about the flat nature of public management networks. Public management networks are far from being flat, especially at the planning stage when the rules, norms and values are developed for future use. However, it is important to understand the nature of hierarchy in public management networks. This hierarchy is not based on rational authority or legal legitimacy, which were described by Max Weber (1964), for, as in the case of the present study, public management networks do not have any legal legitimacy (unless they are federally mandated). Instead, legitimacy or authority in public management networks has a relational character. Legitimacy or authority in these instances is more likely to be defined by the structural characteristics of the network at the node level, such as betweenness centrality or structural autonomy (Wasserman & Faust, 1994). Thus, the power bases of any network actor become highly embedded in the structure of the public management network and depend on the ability of the network actor to exploit the structural opportunities of the network to create public value (Moore, 2000). It is imperative that researchers understand the structural antecedents of “soft hierarchy” in public management networks so that public managers will be able to operate more efficiently and effectively, without being impaired by the nuances of power and authority in their network settings. Therefore, I call for more research on the structural aspects of power, authority and trust in network settings with cross-sector collaboration.
Third, this study has taken a mixed-methods approach to develop empirical assessments of the structural configurations of public management networks over time. Mixed-methods research designs became popular in the field of public administration and public policy in the last decade (Yang & Miller, 2008). However, this approach did not gain prominence among scholars studying public management networks. At present, one group of public management scholars studies public management networks by employing qualitative research methods like the grounded theory approach (Agranoff, 2009, 2012), whereas other groups of scholars use case studies and focus primarily on quantitative research methods (Huang & Provan, 2007; Human & Provan, 1997; Isett & Provan, 2005; Lemaire & Provan, 2009; Milward et al., 2010; Provan, 1993; Provan & Huang, 2012; Provan et al., 2009; Provan, Isett, et al., 2004; Provan, Lamb, et al., 2004; Provan, Milward, & Isett, 2002; Provan & Skinner, 1989). The quantitatively oriented studies treat network development as a black box, without understanding the processes of network development and management. Qualitatively oriented studies focus primarily on the processes leading to the formation, development and management of public management networks, and they tend to ignore the antecedents and outcomes of the networks. Mixed-methods research can serve as a bridge between these two approaches by capitalizing on the strengths of both qualitative and quantitative methods (Riccucci, 2010). Moreover, mixed-method research is better suited to finding answers or solutions to real-life problems like public management networks (J. C. Greene, 2007; Riccucci, 2010) than are other methods. The results of this study indicate that studying complex, multi-faceted social and organizational phenomena like public management networks requires a mixed-methods approach (Tashakkori & Teddlie, 2003). Therefore, it is
recommended that a mixed-methods research design be used in the study of public management networks.

Finally, additional true longitudinal studies on the evolution of public management networks should be conducted to understand the structural and procedural nuances of the formation, development and maintenance of networks across sectors. As mentioned previously, the present study is not a true longitudinal study since the data were not collected at two points in time. Instead, the data for the first wave of data collection (planning stage) were reconstructed based on responses to semi-structured interviews. It is recommended that future researchers track the emergence of new public management networks and begin research at an early stage in a network in order to capture the structural characteristics of the network by means of social network survey instruments that capture the various relations among network participants. It is also beneficial to conduct individual interviews with network participants in order to capture the processes of network development and management. Later, quantitative and qualitative data can be triangulated to create a global, “thick” snapshot of a particular point in time. It is strongly recommended that researchers repeat the same procedure every two to three years in order to understand the dynamics of change in the structure and processes of the public management network under observation. Most current longitudinal studies of public management networks did not start out as true longitudinal studies, and the time lag between data collection and the events they describe is about four years (Isett & Provan, 2005; Milward et al., 2010; Provan et al., 2009). It is recommended that researchers shorten this lag time and increase the number of data-collection waves so as to capture the complexity of the networks over time. Moreover,
more frequent collection of network data will allow for a better understanding of the change in relations among network actors due to environmental effects (Milward et al., 2010).

Summary

This chapter discusses the conclusions and implications of the research findings. The main analytical findings, discovered using the grounded theory approach, suggest that the main network processes leading to the formation and development of public management networks are consistent with the model of network behaviors developed by Agranoff and McGuire (2001b), which includes activating, framing, mobilizing and synthesizing. I developed a theoretical framework that clearly explained the structural development of public management networks over time and tested this framework using sociological, organizational and public management theories at different network levels (actor, dyadic, triadic and global). Policy analysts and public program evaluators can use this framework to understand, measure, and evaluate the main aspects of network effectiveness using statistically robust approaches for network modeling.

Based on the results of exploratory social network analysis (Nooy et al., 2005) and social network analysis (Contractor et al., 2006), some general tendencies in the structure and operation of networks were identified. Centrality plays an important role in the structure of a public management network and tends to increase over the course of the network’s development. Hierarchy in public management networks varies depending on the stage of development. At the early stages of development, public management
networks tend to be hierarchical, but this hierarchy is reduced to the governing core of the network at the implementation stage. Reciprocity of relationships is found to be an excellent indicator for measuring the development of trust, mutual support, and exchange of resources among network participants at the different stages of network development. Reciprocity is highest at the planning stage when the network members are engaged in the processes of setting rules, norms and values for the effective functioning of the network in the future. It is reduced, however, at the implementation stage, when strategic actions and trust have been developed. The structural autonomy of a network actor is found to be an excellent indicator of the degree to which various resources are being utilized in public management networks over time. Because network champions connect the most popular network actors to many other actors, the planning stage is characterized by low structural autonomy and a low level of bridging. Meanwhile, the implementation stage features high structural autonomy and a high level of bridging as network champions start exploiting the resources, knowledge and expertise of those network actors who currently have no connections in the network.

Based on the research findings, it is recommended that public program evaluators use the conceptual and methodological framework of the structural configurations of public management networks in various stages of development to assess the effectiveness of public management networks. The model of network behaviors developed by Agranoff and McGuire (2001b) is recommended for assessing the progress of network development in public management networks. Some structural characteristics such as density, reciprocity, degree centrality, betweenness and transitivity are also suggested for assessing the development of public management networks. For example, reciprocity can
be used as an indicator that shows how trust, mutual support and exchange of resources among the network participants is developed at the different stages of development.

The limitations of the study are discussed at some length. There is concern that the findings of the present study could have limited applicability for other public management networks since this study investigates only a single cross-sectoral network of organizational entities that was formed to establish a high school as the result of implementing STEM. In addition, this study cannot be considered to be a true longitudinal study since the data were not collected at two or three points in time, and the data for the first stage were generated from the guided discussions, long after the fact. Finally, this study is based on only one network, itself representing only one case of implementing STEM initiatives over two periods of time. Therefore, it was recommended that future researchers test the proposed theoretical framework of structural signatures at the different stages of network development against various types of public management networks.

This chapter also discusses several theoretical and methodological implications that can provide guidance to public management scholars in future research on public management networks. It has been recommended to continue studying the structural and process aspects of networked organizations like Metro as well as these aspects’ impact on the performance of public management networks. Also, I call for more understanding of the differences in governance and hierarchy between traditional bureaucratic organizations and networked organizations like Metro school. Based on the results of this study, it is recommended that researchers use a mixed-methods research approach in their analysis of public management networks, as it is the best approach suited to deal with
complex social phenomena such as public management networks (Tashakkori & Teddlie, 2003). Finally, I call for more truly longitudinal studies on the evolution of public management networks, in order to understand the structural and procedural nuances of the formation, development and maintenance of networks across sectors.


Metro. (2012), from [http://www.themetroschool.org](http://www.themetroschool.org)


Appendix A

Metro Network Study Discussion Guide Questions

1. CAN YOU BRIEFLY DESCRIBE WHAT YOUR INVOLVEMENT WITH METRO SCHOOL HAS BEEN, IN BOTH FORMATION AND OPERATION?

2. (If involved in formation. Or go to number 6.) CAN YOU PROVIDE US WITH A REVIEW OF THE MAJOR EVENTS THAT LED TO THE OPENING OF THE SCHOOL'S DOORS IN FALL 2006?

3. WHAT WAS YOUR ROLE IN THIS FORMULATION PROCESS? (Probe for initial understandings and expectations; key supports; loan of staff; expertise, other commitments.)

4. IN ENGAGING IN THESE METRO RELATED ACTIVITIES WITH WHOM DID YOU WORK MOST CLOSELY? (Probe for type or role, contact with other organizations - local-state-national-, probe for executives or staff.)

5. (For top executives only—do not ask others). HAVE YOU PLAYED A CONTINUING ROLE? IF YES, WITH WHOM? (Probe as in number 4.) (For top enablers go to number 16.)

6. Note: Questions for top enablers numbers 1-5 and number 16 only. For others, if not involved in formulation (number 1) go on to question number 6.

7. HAVE YOU EVER BEEN INVOLVED IN WORKING WITH A NETWORKED ORGANIZATION LIKE METRO BEFORE? THAT IS, HAVE YOU HAD PRIOR EXPERIENCE WITH AN ENTITY THAT INVOLVES THE COOPERATION OF MULTIPLE ORGANIZATIONS?

8. (If not answered before.) AS YOU BEGAN TO WORK WITH ONE ANOTHER AS REPRESENTATIVES FROM DIFFERENT ORGANIZATIONS, HOW DID THE WORKING GROUP BEGIN TO DEVELOP MUTUAL UNDERSTANDINGS AND EXPECTATIONS?

9. AS METRO PARTNERS AND SUPPORTERS HOW DID YOU DEVELOP A SENSE OF COMMON STRATEGY AND SET MUTUAL OBJECTIVES? (Probe for involvement in strategic research and for planning and accessing school programs; team curricular planning.)

10. HOW DO THE INTERACTING ORGANIZATION REPRESENTATIVES ENCOURAGE WIDESPREAD PARTICIPATION, EXCHANGE IDEAS, AND LEARN FROM ONE ANOTHER? (Probe for building of learning communities.)

11. HOW IS TRUST AND BELIEF IN WORKING TOWARD A COMMON
PURPOSE BUILT?

12. WERE YOU ABLE TO ENGAGE OTHER ORGANIZATIONS AS YOU WORKED TOGETHER? (Probe for whom and how, particularly surrounding community-based learning experiences, coaching, accessing community resources.)

13. AS A GROUP WORKING TOGETHER HOW DID YOU ARRIVE AT AGREED UPON COURSES OF ACTION? (Probe for both process and decision-making and use of incentives.)

14. AFTER AGREEMENT IS REACHED, WHO IS RESPONSIBLE FOR CARRYING OUT DECISIONS/ACTIONS? TO WHAT EXTENT DO YOU DELEGATE? HOW DOES THE GROUP ENSURE FOLLOW THROUGH?

15. WHAT WOULD YOU POINT TO AS METRO'S MOST NOTABLE ACCOMPLISHMENTS TO DATE? HOW WOULD YOU COMPARE THOSE TO THOSE OF A MORE TRADITIONAL HIGH SCHOOL? (Probe for innovative design, learning communities, student achievement, student growth potential, service learning, work study, etc.)

16. WHAT HAS THE METRO EXPERIENCE MEANT TO YOU, PERSONALLY AND PROFESSIONALLY, OR FOR YOUR ORGANIZATION? (Probe for growth quotient, contacts, learning experiences, skill enhancement, multi-stakeholder collaborative advantages, resource access.)

17. IN YOUR OPINION, IS THERE ANYTHING THAT MAKES METRO UNIQUE AS A SCIENCE, TECHNOLOGY, ENGINEERING AND MATH SCHOOL?

18. NOW, DR. HUNTER, DO YOU HAVE ANYTHING ELSE TO ASK?

19. THE FINAL PHASE OF THIS STUDY INVOLVES A VERY SHORT PAPER AND PENCIL QUESTIONNAIRE ON NETWORK INTERACTIONS. YOUR NAME AT THE TOP WILL ONLY BE FOR OUR RECORDS. BEFORE WE LEAVE WOULD YOU TAKE FIVE MINUTES TO FILL THIS OUT. (Hand them clipboard, paper and pencil [or pen]).

20. THANK YOU VERY MUCH FOR YOUR TIME AND YOUR COOPERATION. IT WILL HELP OUR STUDY IMMENSELY.
Appendix B

Metro School Network Survey

Thank you for agreeing to participate in this research study. All answers will be kept confidential and your identity will not be disclosed for any reason.

Name: _______________________________________________________
Organization: __________________________________________________
Current Job Title: ______________________________________________

1. What is your role/involvement with Metro School (check all that apply)?
   _____ Formation of Metro School
   _____ Metro Partnership Group
   _____ Educational Council
   _____ Metro Learning Partner
   _____ Learning Center
   _____ School employee
   _____ School governance
   _____ Curriculum planning and development
   _____ School assessment/student achievement
   _____ Field learning projects
   _____ Advice and consultation
   _____ Other (please specify): _______

2. One a scale of 1-10, what is your overall assessment of the Metro School thus far (10 being a total success and 1 being a total lack of success In the table on the following page, please initially identify up to 16 people who are most important to you in terms of your involvement with the Metro School. Then respond to the statements listed below and enter them into the corresponding numbers on the next page (note: the rating scale for Number 3 is different from Numbers 4-10, which have the same rating scale).
3: I have known this person for:
0=never  1=Less than one year  2=1-2 years  3=2-3 years  4=3-5 years  5=More than 5 years

4: I provide information to this person on Metro-related topics.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

5: I turn to this person to receive information on Metro-related topics.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

6: I provide financial resources to this person for Metro-related activities.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

7: I turn to this person to receive financial resources for Metro-related activities.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

8: I participate in joint Metro-related planning sessions with this person.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

9: I participate in Metro-related projects with this person.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily

10: I negotiate changes in policies and operations with this person.
0=never  1=yearly  2=quarterly  3=monthly  4=weekly  5=daily
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Appendix C

10 Common Principles of the Coalition of Essential Schools

1) **Learning to use one’s mind well.** The school should focus on helping young people learn to use their minds well. Schools should not be "comprehensive" if such a claim is made at the expense of the school's central intellectual purpose.

2) **Less is more, depth over coverage** The school's goals should be simple: that each student master a limited number of essential skills and areas of knowledge. While these skills and areas will, to varying degrees, reflect the traditional academic disciplines, the program's design should be shaped by the intellectual and imaginative powers and competencies that the students need, rather than by "subjects" as conventionally defined. The aphorism "less is more" should dominate: curricular decisions should be guided by the aim of thorough student mastery and achievement rather than by an effort to merely cover content.

3) **Goals apply to all students.** The school's goals should apply to all students, while the means to these goals will vary as those students themselves vary. School practice should be tailor-made to meet the needs of every group or class of students.

4) **Personalization** Teaching and learning should be personalized to the maximum feasible extent. Efforts should be directed toward a goal that no teacher have direct responsibility for more than 80 students in the high school and middle school and no more than 20 in the elementary school. To capitalize on this personalization,

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2 These principles were retrieved verbatim from the official website of the Coalition of Essential Schools

http://www.essentialschools.org
decisions about the details of the course of study, the use of students' and teachers' time and the choice of teaching materials and specific pedagogies must be unreservedly placed in the hands of the principal and staff.

5) **Student-as-worker, teacher-as-coach.** The governing practical metaphor of the school should be student-as-worker, rather than the more familiar metaphor of teacher-as-deliverer-of-instructional-services. Accordingly, a prominent pedagogy will be coaching, to provoke students to learn how to learn and thus to teach themselves.

6) **Demonstration of mastery.** Teaching and learning should be documented and assessed with tools based on student performance of real tasks. Students not yet at appropriate levels of competence should be provided intensive support and resources to assist them quickly to meet those standards. Multiple forms of evidence, ranging from ongoing observation of the learner to completion of specific projects, should be used to better understand the learner's strengths and needs, and to plan for further assistance. Students should have opportunities to exhibit their expertise before family and community. The diploma should be awarded upon a successful final demonstration of mastery for graduation - an "Exhibition." As the diploma is awarded when earned, the school's program proceeds with no strict age grading and with no system of credits earned" by "time spent" in class. The emphasis is on the students' demonstration that they can do important things.

7) **A tone of decency and trust.** The tone of the school should explicitly and self-consciously stress values of unanxious expectation ("I won't threaten you but I expect much of you"), of trust (until abused) and of decency (the values of fairness,
generosity and tolerance). Incentives appropriate to the school's particular students and teachers should be emphasized. Parents should be key collaborators and vital members of the school community.

8) Commitment to the entire school. The principal and teachers should perceive themselves as generalists first (teachers and scholars in general education) and specialists second (experts in but one particular discipline). Staff should expect multiple obligations (teacher-counselor-manager) and a sense of commitment to the entire school.

9) Resources dedicated to teaching and learning. Ultimate administrative and budget targets should include student loads that promote personalization, substantial time for collective planning by teachers, competitive salaries for staff, and an ultimate per pupil cost not to exceed that at traditional schools by more than 10 percent. To accomplish this, administrative plans may have to show the phased reduction or elimination of some services now provided students in many traditional schools.

10) Democracy and equity. The school should demonstrate non-discriminatory and inclusive policies, practices, and pedagogies. It should model democratic practices that involve all who are directly affected by the school. The school should honor diversity and build on the strength of its communities, deliberately and explicitly challenging all forms of inequity
Appendix D

Philosophy of Metro

The Metro Habits

All members of the Metro community seek to improve their practice of the Metro Habits of Heart and Mind:

1. Effective Communicator
2. Inquiring Learner
3. Active and Responsible Decision Maker
4. Effective Collaborator
5. Critical Thinker
6. Engaged Learner

Educational Philosophy

Metro is guided by the Ten Common Principles of the Coalition of Essential Schools. These 10 principles are inspiring high school redesign across the nation. The Ten Common Principles are:

1. The school’s central intellectual purpose is helping students to use their minds well.
2. An essential body of knowledge, skills and dispositions will be identified for student mastery.
3. The school’s goals apply to all students.

3 Retrieved from http://www.themetroschool.org
4. The school will be highly personalized.
5. A governing practical metaphor will be “student-as-worker, teacher-as-coach.”
6. Teaching and learning will be documented by student performance on real tasks.
7. The tone of the school will be one of trust and decency.
8. The principal and teachers will act as generalists first and specialists second.
9. Resources will be modest and therefore positioned toward teaching and learning.
10. The school will emphasize democratic, fair and equitable practices.

The curricular approach to instruction has a dual focus: literacy (math and reading) and real world investigation (social science, life science, and environmental science). To attain this focus, Metro has developed and implemented an integrated math and science curriculum where mathematics becomes a component of the “language” of science. This approach emphasizes the importance of a fluent knowledge of mathematical and scientific process, application through more in-depth science exploration, elements and aspects of design, and innovation. As a component of the “language” of science, students must demonstrate their ability to communicate numerically, graphically, algebraically, verbally, and in writing their understanding and evaluation of empirical evidence in all that they do.

Metro has a holistic approach to educating the students—focusing on cognitive, social, emotional and physical development through experiential learning, service learning and family and community support. Each family is an integral component of Metro's decision-making process. We call this process, STEMocracy. Using tools like our Town Hall Meetings, policy is established from the governed through responsible citizenry.
Curricular Approach and Philosophy

Metro — A Unique Philosophy and Opportunity

• Students participate in an integrated curriculum that fosters critical thinking, creativity and communication.

• Academics emphasize how math, science and technology shape our world.

• Students learn in a community that honors democracy, diversity and ethical leadership.

• Faculty and mentors focus on the talents of the whole student.

• Faculty and students work on projects that benefit the greater community.

• The school is a focal point of professional development, educational research and innovation.
## Appendix E

### Roles/Involvement of 28 discussants with Metro HS

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<th>Respondent</th>
<th>Organization</th>
<th>Formation of Metro school</th>
<th>MPG</th>
<th>Educational Council</th>
<th>Metro Learning Partner</th>
<th>Learning Center</th>
<th>School governance</th>
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CURRICULUM VITAE

Aleksey Kolpakov

School of Public & Environmental Affairs,
Indiana University - Bloomington
315 East 10th Street, R. 340
Bloomington, IN 47405, U.S.A.
Tel: +1-812-361-8144; +1-812-857-9470
E-mail: avkolpak@indiana.edu; avkolpak@gmail.com

EDUCATION

Indiana University, 2005 - 2012, SPEA, Bloomington, IN
Ph.D. major fields are Public Management and Policy Analysis; doctorate minor concentrations are Sociology (Social research methods) and Human Resource Management & Organizational Behavior (Kelley School of Business); Expected date of graduation: May 25, 2012.

Dissertation Research: The main goal of the dissertation is to develop and test the conceptual framework of structural development of public management networks over time. The present research has three foci: it offers a framework of structural tendencies of public management network organizations using a multi-theoretical multilevel approach in the dynamic perspective, it suggests propositions about structural configurations of public management networks in the different stages of network development and it tests suggested propositions regarding structural tendencies of public management networks over time. Therefore, the present research is intended to answer the following questions that are both practically and theoretically important - at the theoretical level, it moves away from traditionally adopted public administration approaches to describe and explore network processes at one level and using one theory to actually confirm and make inferences using multiple theories and different levels of the networks. Using the case of Metro High School in Columbus, Ohio, I test a theoretical framework of the structural development of public management networks over time using different theories at the different levels of networks. What processes are predominant for each stage in the evolution of public management networks? What are the structural configurations of public management networks in the different stages of network development at levels of the network (actor level, dyadic level, triadic level and global level)? What is the effect of individual characteristics of the network actors such as gender, sector differences and inter-organizational network experience of on the structural configurations of public management networks over time? How does social capital affect structural development of the public management network over time?
**Research Interest in Public Management:** Collaborative governance, network management, network sustainability, evolution of public management networks, power sharing in networks, public personnel motivation, public sector leadership, knowledge management, managing diversity in the public sector, bureaucratic discretion in the decision making process, organizational and social identities of street level bureaucrats, organizational change, organizational learning, organizational culture of public organizations

**Research Interest in Nonprofit Management:** Sustainability of nonprofit networks, nonprofit organizations in international development, knowledge management in nonprofit organizations, diversity management in nonprofit organizations, organizational learning in nonprofit organizations, and collaborative practices of nonprofit organizations

**Research Interest in Social Research Methods:** Triadic census in social network analysis, block modeling in social network analysis, ERGM and p*models in social network analysis, stochastic dynamic modeling of organizational networks, narrative analysis and qualitative causal analysis in Public administration


**Kyrgyz Technical University, 1995-1997,** Department of Business and Management, Bishkek, Kyrgyz Republic: Master of Business Administration equivalent, graduated with Honors.

**Undergraduate Education:**
**Kyrgyz Technical University, 1992-1997,** High College of English, Bishkek, Kyrgyz Republic: Diploma in English Language and Literature.

**FACULTY DEVELOPMENT:**

**School of Public and Environmental Affairs, 2000-2001,** Indiana University, Bloomington, IN: Specialized in teaching Public Management courses – Public management, Managing Behavior in the public sector, Human Resource Management, Managing Diversity in the public sector, Conflict Resolution and Negotiation in the Public Sector

**University of North London December 1999,** School of Governance, London, UK: Specialized in teaching Public Management courses – Public Management and Organizational Change in the Public Sector


**PUBLICATIONS:**

**Books**


**Chapters**


**CONFERENCE AND WORKING PAPERS**


Agranoff, Robert, McGuire, Michael and Kolpakov, Aleksey. “Understanding Interoperability in Collaborative Management: Lesson from a Network Agency”, final draft for submission to *The Journal of Public Administration Research and Theory*
McGuire, Michael and Kolpakov, Aleksey. “Using Mixed Methods Network Analysis to study the Development of Public Management Networks”, final draft for submission to *The Journal of Public Administration Research and Theory*


Kolpakov, Aleksey. “Examining the influence of social and organizational identity on the administrative discretion practices of street-level bureaucrats,” paper presented at the 2010 Midwest Political Science Association, Chicago, IL: April 22-25, 2010


Jemiai, Yolande and Kolpakov, Aleksey. “Managing Diversity in the Public Sector”, report presented at the Annual Conference of the International Association of Schools and Institutes of Administration, Athens, Greece: July 2001

Kolpakov, Aleksey. “Management of Interethnic Relations in the Kyrgyz Republic” paper presented at the eight Annual Central Eurasian Studies Conference, Bloomington, IN: March 30-April 1, 2001
UNIVERSITY TEACHING EXPERIENCE

June 2006 to the present:

**Associate Instructor**
Course instructor for *Management: Foundations and Principles V-241*, undergraduate introductory management course for management major. Indiana University, SPEA, Bloomington, IN
Course instructor for *Statistical Techniques K-300*, undergraduate statistics course for public affairs/social sciences students. Indiana University, SPEA, Bloomington, IN
Course instructor for *Management Science V-348*, undergraduate core course for Policy Analysis major. Indiana University, SPEA, Bloomington, IN
Course instructor for *Managing Behavior in Public Organizations V-366*, undergraduate core course for Public/Nonprofit Management and General Management majors and Human Resources minor. Indiana University, SPEA, Bloomington, IN
Course instructor for *Human Resource Management in the Public Sector V-373*, undergraduate core course for Human Resources minor. Indiana University, SPEA, Bloomington, IN
Course instructor for *Managing Workforce Diversity V-443*, undergraduate upper level course for management majors and Human Resource minor. Indiana University, SPEA, Bloomington, IN
Course instructor for *Managing Workforce Diversity V-550*, Master of Public Administration elective course for management majors. Indiana University, SPEA, Bloomington, IN

September 2004 to May 2005:

**Lecturer:**
Business Administration Department: Taught core and elective courses for management major (Organizational Behavior, International Organizational Behavior, Organizational and Social Decision making). American University - Central Asia, Bishkek, Kyrgyz Republic

September 1999-May 2005

**Lecturer:**
Business Administration Department: Taught core and elective courses for management major (Business and Professional Communication, Organizational Behavior, Negotiation Skills, International Management, Presentation Skills). American University - Central Asia, Bishkek, Kyrgyz Republic
Psychology Department: Taught core and elective courses (Intro to Organizational/Industrial Psychology, Training and Development). American University - Central Asia, Bishkek, Kyrgyz Republic

American Studies Department: Taught core and elective courses (Social Pluralism in the United States, American Government, and American Institutions). American University - Central Asia, Bishkek, Kyrgyz Republic

January 2001 to May 2001:

*Adjunct lecturer*

Course instructor for *Managing Workforce Diversity* V-443, undergraduate upper level course for management majors and Human Resource minor. Indiana University, SPEA, Bloomington, IN

Course instructor for *Managing Workforce Diversity* V-550, Master of Public Administration elective course for management majors. Indiana University, SPEA, Bloomington, IN

*September 1998-May 2005*

*Lecturer:*

Master of Public Administration Program: Taught MPA core and elective courses for all specializations (Organizational Behavior, Human Resource Management, Project Management, Presentation Skills, Managerial Skills, Managing diversity in the public sector, Organizational Decision making, Organizational Change and Development, Preventive Development). Academy of Management under the President of the Kyrgyz Republic, Bishkek, Kyrgyz Republic

Master of Business Administration Program: Taught MBA core and elective courses (Organizational Behavior, Human Resource Management, Presentation Skills, Managerial Skills, Communication skills, International Management). Academy of Management under the President of the Kyrgyz Republic, Bishkek, Kyrgyz Republic

Bachelor of Public Affairs Program: Taught core and elective courses for management specialization (Management, Strategic Management, Organizational Behavior, Human Resource Management, Ethics, Organizational Theory, Organizational Decision making). Academy of Management under the President of the Kyrgyz Republic, Bishkek, Kyrgyz Republic

*September 1997-September 1999*

*Instructor:*

Department of International Relations Taught undergraduate courses at various levels (Conversational English, Political and Official English, English for Specific Purpose, Business English, Principles of Translations). Integration International Education Programs Institute, Bishkek, Kyrgyz Republic
PROFESSIONAL AND PROJECT EXPERIENCE

April 2012 to September 2012
**National Consultant:** developing and testing methodology/guideline of conflict sensitive expertise for legislation with a glance at international relevant experience; assisting in development of cases on analyzing laws in terms of conflict sensitivity; providing expert support in analyzing laws on potential conflicts, providing on-line expertise and coaching to the team of local legal experts

June 2012 to July 2012
**National Consultant:** revising training materials and the manual on advanced level module on conflict sensitivity; conducting training of trainers on advanced level module on conflict sensitivity for public, private and nonprofit organizations. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

January 2012 to February 2012
**National Consultant:** conducting a three-day test training on advanced level conflict sensitivity for 30 representatives of UNDP/UN programs; conducting five-day TOT on Do No Harm (intermediate level). Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

July 2011 to November 2011:
- **National Consultant:** developing practical toolbox for implementing conflict sensitivity in United Nations Development (UNDP) Programs, developing and conducting an advanced training course on facilitation of reconciliation in the communities; developing training materials and advanced level module on conflict sensitivity, conducting workshop on conflict monitoring. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

January 2011 to March 2011:
- **National Consultant:** designing and conducting intermediate level training on conflict sensitive approach for UNDP and Department for International Development (DFID) staff and nonprofit organizations. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

June 2010 to November 2010:
- **National Consultant:** assisting to assess the overall staff and partner understanding of conflict prevention/conflict sensitivity and capacity in developing and implementing conflict sensitive programs, including the gender dimension; designing and finalizing a module on basic sensitization and awareness raising training on conflict prevention and the conflict sensitive approach for UNDP and Department for International Development (DFID) staff and partners; developing and facilitating four-day training on Evaluation for Conflict Transformation for the program staff and nonprofit organizations. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

June 2009 to August 2009:
- **National Consultant:** developing and facilitating workshops for the key staff of the UNDP Programs in order to mainstream the results of Peace and Development Analysis into UNDP programs; developing and facilitating four-day training course
on Monitoring and Evaluation for the program staff of UNDP Peace and Development Program and managers of other UNDP program; reviewing the current system of Monitoring and Evaluation at UNDP Peace and Development Program. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

March 2008 to April 2008:
  Research Assistant: providing research support in public program evaluation of Metro School to Dr. Robert Agranoff and Dr. McGuire Indiana University, Bloomington, IN

January 2008 to February 2008
  National Consultant: developing and facilitating three-day training for PDP staff in Conflict Prevention Mainstreaming (CPM) methodology, providing tools and techniques for CPM in general, and in conflict prevention impact analysis; facilitating workshops for Peace and Development Analysis (PDA) facilitators; updating conceptual framework for mainstreaming conflict prevention into UNDP-Kyrgyzstan programs, developing and facilitating four-day training on Conflict Management Systems and Networks for PDP staff and nonprofit organizations. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

June 2007 to August 2007:
  National Consultant: developing training modules on mainstreaming Conflict Prevention into UNDP programs; facilitating workshops mainstreaming Conflict Prevention into UNDP programs. Peace and Development Program, UNDP-Kyrgyzstan, Bishkek, Kyrgyzstan

January 2005 to August 2005:
  Chair: Department of Business Administration: coordinating and developing curriculum, budgeting, planning, and selecting/hiring faculty
  Acting Director: Master of Business Administration Program: coordinating and developing curriculum, budgeting, planning, and selecting/hiring faculty

October 2004 to July 2005:
  Consultant/Trainer: introducing a Systemic Training Needs Analysis for conflict prevention training courses in the south of the Kyrgyz Republic; conducting workshops on data collection for qualitative research; revising and editing 2004 Annual Preventive Development Report. UNDP-Kyrgyzstan Preventive Development Program, Bishkek, Kyrgyzstan

October 2004 to December 2004:
  Lead Trainer: designing program for Training of Trainers on Human Resource Management in the Public Sector; developing and conducting modules on Public Management, Fundamental Principles of HRM, Managing Career of Civil Servants, Stress Management. TACIS project Assistance to the Civil Service Reform in the Kyrgyz Republic, Bishkek, Kyrgyzstan
August 2002 to September 2003:
Training Officer: introducing a Systemic Training Needs Analysis for local governance bodies in the Kyrgyz Republic; designed training manuals for basic training courses in Local Governance, conducting Training of Trainers courses for project staff; coordinated the planning of the training courses for local governance bodies at the pilot areas; evaluating effectiveness of training courses in the pilot areas, UNDP project “Political and Administrative Governance at the Local level”, Bishkek, Kyrgyzstan

January 2002 to August 2002:
Trainer/Consultant: developing sessions on managing diversity for adult and student groups, teaching a module on managing diversity in the Kyrgyz Republic, Conrad Adenaur Foundation project “What is Democracy?” Bishkek, Kyrgyzstan

September 2001 to August 2001:
Trainer/Consultant: designing a module on basics of effective management, developing training materials; conducting Training for Trainers course, Eurasia Foundation project “Improving skills of Business Administration teachers at the regional universities” Bishkek, Kyrgyzstan

October 1999 to May 2000:
Coordinator: acting as a liaison person in the pre-phase period, assisted in writing grant proposal, providing organizing trips of faculty to United Kingdom, writing intermediate and final reports, developing training materials; conducting Training for Trainers course, Regional Exchange Academic (REAP) project “Review and Development of the Master Degree in Public Administration to reflect major changes in public management and municipal governance” between University of North London and Academy of Management under the President of the KR” Bishkek, Kyrgyzstan

FIELD DATA/SURVEY COLLECTION EXPERIENCE

April 2008 to December 2008:
Team Leader: Peace and Development Program, UNDP-Kyrgyzstan: principal investigator for evaluating effectiveness of training courses on conflict resolution in the Osh and Jalal-Abad region June/October 2003; designing the process of training impact evaluation in the pilot areas of Peace and Development Program, developing and testing questionnaires and interview guides; providing guidance to Data Collection Organization during the stage of data gathering of and training impact evaluation, analyzing data gathered during training needs assessment and training impact evaluation in the pilot areas of Peace and Development Program, writing final report and proposing recommendations to improve training courses in conflict resolution.
September 1999 to May 2000

**Data collector:** Interethnic Relations Survey: The survey dealt with the attitudes towards and perceptions about interethnic relations in the Kyrgyz Republic. Duties: collecting data in higher educational establishments and settlements of ethnic minorities.

September 1998 to December 1998

**Principal investigator:** TACIS project ‘Strengthening Civil service reforms’. The survey was aimed at identifying the challenges to effective communication in the civil service of the Kyrgyz republic. Duties: developing and testing survey on the challenges to effective communication; entering and cleaning the data; running descriptive statistics analyses, writing up results of the survey and preparing report.

GRANT WRITING/FUNDRAISING EXPERIENCE

**Academy of Management under the President of the Kyrgyz Republic:**
- Regional Exchange Academic Programs (REAP) project ‘Review and Development of the Master Degree in Public Administration to reflect major changes in public management and municipal governance” between University of North London and Academy of Management under the President of the KR, December 1998 to May 2000 – 22,175 British pounds

ACHIEVEMENTS & AWARDS

- Consortium for Qualitative Research Methods Fellowship: School of Public and Environmental Affairs, Indiana University, June 2011
- Annual Political Network Conference Fellowship: National Science Foundation, US, 2010
- Global Supplementary Grant Award: Doctorate student award, OSI - New York, NY: 2009-2010
- Global Supplementary Grant Award: Doctorate student award, OSI - New York, NY: 2008-2009
- Global Supplementary Grant Award: Doctorate student award, OSI - New York, NY: 2007-2008
• Junior Faculty Development Fellowship: American Council for International Education, Washington, DC, 2000-2001, placement: Indiana University, Bloomington, Indiana, United States
• Silver Medal: Outstanding National Student, High School # 28. Bishkek, Kyrgyz Republic, 1999

LANGUAGE SKILLS

• Russian: fluent (native language)

STATISTICAL PACKAGES/COMPUTER SKILLS

• Solid expertise with general statistical applications (in the order of proficiency, from strongest to adequate mastery: STATA, [R] and SPSS)
• Solid expertise with social network analysis applications (in the order of proficiency, from strongest to adequate mastery: UCINET, Pajek, NetDraw, PNet, RSiena, LNet)
• Strong computing skills in Microsoft Office package

MEMBERSHIP & SERVICE

University Committee Service

• **Member of Faculty Promotions Committee:** American University - Central Asia. Bishkek, Kyrgyz Republic: September 2002-August 2003
• **Member of Admission Committee:** Business Administration Department, American University - Central Asia. Bishkek, Kyrgyz Republic: Sep. 2001-August 2003, September 2004-August 2005
• **Member of Admission Committee:** MBA Program, American University - Central Asia. Bishkek, Kyrgyz Republic: September 2001-August 2003, September 2004-August 2005

Volunteering

• **Counterpart of Peace Corps Volunteer:** Academy of Management under the President of the Kyrgyz Republic. Bishkek, Kyrgyz Republic: September 1999-May 2000

Manuscript Reviews for Journals and Conferences

• Public Administration Review
• Academy of Management Annual Conference
• Sage Publication
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