Mapping Theory to Practice: A Cartographic Analysis of Public Safety Networks

Christine B. Williams*
Bentley College
Waltham, MA 02452
cwilliams@bentley.edu

Steve Sawyer**
The Pennsylvania State University
University Park, PA 16802
sawyer@ist.psu.edu

Jane Fedorowicz
Bentley College
Waltham, MA
jfedorowicz@bentley.edu

M. Lynne Markus
Bentley College
mlmarkus@bentley.edu

Martin Dias
Bentley College
dias_martin@bentley.edu

Dax Jacobsen
Bentley College
djacobson@bentley.edu

Michael Tyworth
The Pennsylvania State University
mtyworth@ist.psu.edu

Sonia Vilvovsky
Bentley College
soniavilvosky@gmail.com

* 01-781-891-2655
** 01-814-865-4450

ABSTRACT
This paper provides an interim report on ongoing data collection and analysis efforts as part of a large-scale study of information technology-focused interagency collaborations in the United States public safety sector—collaborations we refer to as public safety networks (PSNs). Of particular interest are shared infrastructures for supporting technological interoperability and interagency interactions involving policing, criminal justice, and homeland security processes. Our research questions focus on explanations for the formation of PSNs and for their design, use, governance, and success. The paper describes our rational choice and institutional theoretical perspectives on PSN formation, ongoing data collection efforts, and map-based visualizations we have developed for data exploration and analysis. Preliminary analyses suggest that our approach is promising for generating insights about PSNs and, by extension, about other types of interorganizational collaborations focusing on information-sharing and the use of information and communication technology.

Categories and Subject Descriptors

General Terms
Measurement, Documentation, Theory.

Keywords
Public safety, interorganizational collaboration, information and communication technology, rational choice theory, institutional theory.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.
dgo 2008, May 18-21, 1008, Montreal, Quebec, Canada
Copyright 2004 ACM 1-58113-000-0/00/0004...$5.00.

1. INTRODUCTION
Public Safety Networks (PSNs) are interagency collaborations focusing on the development and use of information and communication technologies (ICT) to support the information sharing and interoperability needs of police and other public safety organizations. This paper reports early progress on a large-scale study that addresses two key questions about PSNs:

1. Why do PSNs occur in some places and not in others?
2. What makes PSNs successful?

The major theoretical perspectives on the first question include rational choice theory, which focuses on agencies’ needs for ICT support, their resources, and their costs of participating in PSN collaborations; and institutional theory, which focuses on shared strategies, norms, and rules and the processes by which these elements become shared, for example, through imitation or coercion. To explore the relative explanatory power of rational choice and institutional theories regarding the formation of PSNs requires the collection and analysis of a vast array of data about PSNs and their practical and institutional contexts. This paper describes our ongoing efforts to collect, represent, and analyze data about PSNs and their environments with the aim of answering theoretically motivated questions about their formation and success.
From numerous secondary sources we have created a data set of over 160 state, county, and local PSNs and a corresponding data set of contextual data, primarily at the state level. Our preliminary analysis strategy consists of generating state-by-state maps of PSNs and state-level contextual data, thus allowing us to explore theoretically-driven questions about where PSNs are most likely to occur and why. Over the next year, these data sets will be supplemented with new primary data collection addressing the governance and technology arrangements of the PSNs along with indicators of their achieved outcomes and overall success.

In section 2, we describe the PSN phenomenon. In section 3 we briefly review the rational choice and institutional explanations of PSN formation. Section 4 reports on our collection and use of secondary data about PSNs and their contexts. In section 5 we illustrate our preliminary analyses with selected maps, and in section 6 we show how these analyses may be used for further explorations and theoretical development. We conclude with a brief discussion of the contributions of our work.

2. PUBLIC SAFETY NETWORKS

In PSNs groups of public sector agencies and private organizations come together to collaborate on issues related to ICT, in some instances developing ICT infrastructures to support interoperability and interaction among member organizations. Interest in, and development of, such collaborative arrangements have increased substantially over the past fifteen years [1, 6, 8, 4], and PSN activity has been given new impetus by the challenges of the post 9/11 environment. PSNs represent an innovative and rapidly diffusing organizational form. Currently, there are dozens of documented initiatives engaged in developing collaborative infrastructures for homeland security, emergency response, and criminal justice information sharing at regional, state, and local levels [7].

Public safety agencies engage in many forms of collaboration related to information and communication technology. They may collaborate to share information about new technology developments, to achieve the benefits of joint purchasing, to create sharing information processing or business process services, or to develop new technology for supporting interaction and interoperability among their participating organizations. Here, we confine our analysis to PSNs that have built shared infrastructures for communication or information processing. In addition, the PSNs we examine are characterized by their objectives to support:

- public safety – criminal justice, emergency management, and or homeland security
- interagency governance – arrangements for joint policy making and for the management of shared technology resources
- interagency uses – crossing geographic, functional and/or governmental levels
- police and their partners – government agencies and private organizations
- routine operation – such as patrol and criminal investigation, although they also can be used for emergency management or decision support

PSNs are further characterized by their:

- mixed technology infrastructure – consisting of ICT resources that are both private, that is, owed by individual agencies, and shared, that is, supporting interoperability and interaction across agencies

PSNs can be found in every state. And they occur at every level of government: city, metropolitan area, county, state, and regional. For example, ARJIS began as a criminal justice initiative within San Diego and has grown to provide support to the surrounding region [12]. Another PSN, JNet, provides assistance to a wide variety of criminal justice agencies within Pennsylvania [11]. CapWIN is a widely recognized regional effort that supports public safety activity across parts of Maryland Virginia and the District of Columbia [4]. These and many other examples are included in the data set we describe in the following sections.

3. PERSPECTIVES ON PSN FORMATION

There are numerous influences on the formation, structure, and operation of PSNs. As shown in Figure 1, PSNs operate within three domains: the public sector, the policing function and the technology sector. Each domain creates conditions that shape the nature of interagency collaborations and the infrastructures that result from such collaborations.

The Public Sector domain shapes interagency collaboration through such influences as governmental processes for technology funding and procurement and the authority and dominance relationship among agencies such as federal organizations versus state police. The Public Safety domain raises additional issues, such as the unique demands of the different processes that may be supported by a PSN, which can range from community policing to emergency management to homeland security efforts. The ICT domain is a third source of influence on the shape of interagency collaborations: public safety agencies have highly varied ICT infrastructures in terms of their amount of “legacy” technology, their use of custom developed or COTS (commercial off-the-shelf) software, their employment of proprietary vendor technology versus open standards, etc.

As a result of these influences, PSNs differ widely in their technological and governance arrangements. Some PSNs build bridges to connect the technology resources of member agencies; others develop substantially new infrastructures. Some PSNs are governed by one powerful agency; others create new organizations of varying legal standings.

Figure 1 also depicts the two primary theoretical perspectives on PSN formation. Rational choice theory emphasizes the practical purposes for which PSNs are created; institutional theory emphasizes historical influences and the role of political legitimacy and conformity in the diffusion of the PSN organizational form and practices. We elaborate on these perspectives below.
Influences on PSN Formation

3.1 Rational Choice Perspective
As applied to PSNs, rational choice theory holds that agencies make choices about whether to participate in collaborations and what kinds of collaborations to form on the basis of “efficiency” concerns such as expected performance improvements [2, 5, 9]. Key issues in this perspective are agencies’ needs for performance enhancement, the resources required, and the costs of or barriers to participation. Agencies such as state governments can differ on all three dimensions, leading to the expectation that PSNs will be unequally distributed across states.

For example, having greater population density, an international border, or a higher crime rate are “needs” factors that may predispose a state to initiate, promote, or participate in PSNs. “Resource” factors include funding sources and technological expertise. “Cost” factors include poor quality ICT infrastructures.

Rational choice predicts that the incidence of PSNs will be positively related to “needs” factors such as crime rates or population density, positively related to “resource” factors such as funding levels and sources, and negatively related to “cost” factors such as quality of ICT infrastructure. The collection of numerous state-level indicators will allow us to test these predictions and to compare them with the predictions of institutional theory, discussed below. Although the rational choice and institutional perspectives are often described as conflicting, some authorities believe they are complementary [9], such that considering the perspectives together could lead to an improved understanding of PSN formation.

3.2 Institutional Perspective
Some institutional theorists emphasize the historical influences on organizational formation, structure, and functioning. An important example in the PSN context is a history of prior collaborative relationships among the PSN’s member agencies [2]. Many other institutional theorists share the view that the choices of organizations are shaped more by concerns about legitimacy and survival than they are by concerns about efficiency and performance [10, 13]. Within this school of thought, organizations experience strong pressures to conform to practices that are deemed legitimate by virtue of shared norms, coercion by powerful actors, or imitation of influential peers. These pressures are theorized to drive adoption of new practices such as interagency collaboration and new organizational forms such as PSNs.

Again, agencies such as state governments can be expected to vary in the institutional pressures they face with respect to participation in PSNs. For example, some states may face legislative mandates for interagency collaboration or operate under laws and regulations that limit their budgetary discretion. State rankings or “report cards” on ICT or information management performance may exert normative influences promoting or hindering PSN participation. Imitative influences may derive from knowledge about what other states are doing, particularly neighboring states or states with similar ICT governance arrangements.

Institutional theory leads to the expectation that PSNs are more likely to occur in states where there are, for example, legislative mandates, poor ICT or information sharing “report cards”, and neighboring states with a high concentration of PSNs. As mentioned earlier, institutional theory predictions can sometimes complement predictions derived from rational choice theory. As an example, federal government pressures on states to participate in PSN arrangements are likely to be higher in states characterized by certain “needs” factors, such as an international border.

4. DATA: SOURCES, COLLECTION & USE
To explore these theoretical explanations for PSN formation, we have been engaged in an ongoing process of data collection and analysis. To this point, data collection has focused mainly on secondary sources. However, we are currently finalizing plans for the collection of primary data by means of interviews with ICT executives in each state and with leaders of individual PSNs.

To date, we have assembled two large data sets from secondary sources, one comprising indicators of rational choice and institutional factors at the state level, the second comprising published data on individual PSNs. For each state, we have collected a wide range of descriptive data about geography, population, public safety organization and funding, political context, and IT governance and performance. For example, we have characterized states in terms of population density, land area in square miles, and presence/absence of an international border. Indicators of a state’s political climate include the degree of two party competition, whether the legislature is full or part-time, the degree of state fiscal dominance relative to local discretionary authority, and the number of agencies. Organizational attributes include the state’s crime rate, homeland security appropriations, expenditures for police protection, number of police protection personnel, and number of law enforcement agencies. Indicators of a state’s IT status and performance include the percentage of the IT budget derived from a budget assessment, service fees, and bond issues, and the Government Performance Project Management Report Card for IT. Sources of these data include federal offices such as the Department of Justice and the U.S.
Census\(^1\), professional associations such as NASCIO\(^2\), and independent and university-based research centers\(^3\).

Using other secondary sources, we have identified and captured public information about more than 160 PSNs. We learned about these collaborations through Web searches of research sites such as SEARCH\(^4\), from federal, state and local Web sites, through newspaper articles, and a wide range of trade press publications\(^5\). We also attended PSN-oriented conferences and consulted with professionals at government agencies and independent research centers in an attempt to complete our inventory of PSNs across all levels of government. These efforts continue, as new PSNs are announced or begin operations. We anticipate finding additional PSNs through our forthcoming interviews of state executives.

We plan to analyze our data through a variety of statistical and qualitative techniques. A particularly promising approach involves the visual display of data by means of layered maps that can be superimposed to reveal different kinds of relationships, for example, between the incidence of PSNs and presence of various rational choice or institutional factors. For the illustrative analyses we present below, we focus on the distribution of local-level and state-level PSNs (that is, PSNs of which the majority of members are local or state agencies) in conjunction with state-level indicators of “needs” for participation in PSNs.

5. MAPPING PUBLIC SAFETY NETWORKS

In this section we illustrate the qualitative portion of our data analysis strategy by mapping the geographic distribution of PSNs for which we currently have data and by mapping some of our state-level contextual data.

Figure 2 graphically depicts the geographic distribution of state-level PSNs by state. State-level PSNs are PSNs of which the majority of members are state agencies. Color shading on the map indicates the number of PSNs in each state. (Darker shading means more PSNs.) Figure 3 shows the density of local-level PSNs within each state, where local-level PSNs are those in which the members are county, city, or metropolitan-area entities. Figure 4 combines the data from these maps, giving the total PSN density by state.

- Figure 2: PSN Density by State\(^6\)
- Figure 3: PSN Density at Local Levels (County, City or Metropolitan Area)
- Figure 4: Total PSNs within States (Compiles Figures 2 and 3)

Through inspection of the maps, we observe that every state has at least one state-level PSN, suggesting the strong possibility of institutional influences. Local-level PSNs are more numerous in the most populous states and those that have an international or ocean border, in keeping with a rational choice explanation. As we expand the range of our representations of PSNs in the future, characterizing them for instance in terms of their technological infrastructure and governance mechanisms, we expect the maps not only to depict the relationships for which we now have data, but also to suggest new factors that may explain PSN numbers and locations.

To illustrate how the maps will be useful in exploring and visualizing the answers to our research questions, we present below cartographic representations of two of “needs”-related (rational choice theory) variables for which we have data. Figure 5 maps the 1999 crime rate from the 2000 U.S. Census. Figure 6 displays population density, computed from U.S. Census population statistics and data about states’ land masses.

- Figure 5: State Crime Rate (U.S. Census, 2000)
- Figure 6: State Population Density (U.S. Census, 2000)

As shown in Figure 5, the crime rate is higher in Southern states and lower in the North Central states. Figure 6 shows that the most densely populous areas are the Northeast, Florida, Illinois and California. Juxtaposing these two maps it is apparent that dense population is not a strong indicator of high crime rates, and that in fact some of the least populous states have high levels of crime. Clearly the linkage between these rational choice factors is complex, yet both may play a role in the emergence of PSNs.

Viewing PSN density (Figure 4) in light of Figures 5 and 6 suggests several potential relationships between PSN incidence and the “needs” factors of crime rate and population density. PSNs appear to be more frequently located in areas with dense populations, high crime rates, and an international border. A crosstabulation of the bivariate relationships between PSN categories and crime rate categories yields Tau\(c\) correlation coefficients of -.050 (state level) and +.124 (total number). We did not compute the coefficient for number of local PSNs because that variable has insufficient variation. Between population density categories and PSN categories, the coefficients are +.273 (state) and +.266 (total number). For international border, the coefficients are +.258 (state) and +.309 (total number). Clearly, more detailed statistical analyses are needed. But our mapping approach appears to be a powerful tool for data analysis, and we expect that it will also prove useful for sharing our findings with the practicing PSN community, with government funding sources, and with state and local administrators.

6. TOWARD FURTHER ANALYSIS

The simple representations presented here hint at the level of PSN activity in the US and the complex political, economic, social and technological issues that influence their creation and characteristics. The population density and crime rate maps are illustrative of a large array of possible overlays. Other factors of interest include the size of state budgets for administration, policing, and IT. These figures may be related to “needs” factors like population density or to institutional factors such as the states’ political orientation or the ideology of community policing.

---


\(^2\) See http://www.NASCIO.org.


\(^4\) http://www.SEARCH.org

\(^5\) See for example, http://www.govtech.com

\(^6\) For Figures 2 – 6, please consult the full-size figures at the end of the text.
Our initial representations raise challenging questions about data aggregation and representation. For example, we aggregated crime rates by state, but it could be argued that crime is fundamentally a local phenomenon. A public safety initiative may have been formed in response to perceptions that the crime rate was too high in the state or in response to perceptions that the crime rate was too high in a particular county or local area only. Our separation of PSNs by level (state versus local) may be useful in shedding light on such questions.

We know that population and crime are not evenly distributed across geographic and jurisdictional boundaries. This condition is problematic with respect to political influences and power. For example, a city like Chicago may have a high crime rate, while crime rates in the rest of the state remains relatively low. The Illinois legislature has been dominated historically by downstate interests and thus may not respond to a high average crime rate skewed by the inclusion the Chicago metropolitan area. Moreover, many parts of Chicago may have low crime rates, or varying rates of particular crimes (e.g., drugs versus domestic abuse); thus, different locations within a region may have very different interests relative to policing and public safety. This means that the formation of PSNs may be a contentious political activity. Future PSN analyses may require more granular analyses, as illustrated in the contrasts Figures 2 and 3, or comparative analyses with varying levels of aggregation.

As we conceptualize them, population density and crime rates are indications of “needs” for PSNs. However, “needs” can be understood in subjective as well as objective terms. New York may have one of the highest crime rates in the country, ostensibly favoring PSN formation. However, crime fighting may not have a high political priority in New York compared with education, mass transit, or pollution—a situation clearly less favorable for the formation of PSNs. Future work is needed to represent political priorities as a complement to objective measures of “needs”.

7. DISCUSSION

The data mapping activities described above represent only the earliest stages in research project in which data—both primary and secondary—are still being collected. Even at this stage, however, it seems clear that our data and analytic approach will be productive in identifying patterns that can explain the formation of PSNs and, eventually, their characteristics and success. Thus, we believe that both our data sets and our mapping approaches represent a contribution to knowledge about collaborative activity in government in general, and more particularly in public safety contexts and with respect to ICT.

We significantly underestimated the challenges involved in compiling our data sets. We expected to find, but did not, central repositories of PSN initiatives and common ways of describing their structure, governance, and technological arrangements. We did find a few compilations, such as the survey of communications and information sharing initiatives housed primarily in a local police department conducted by the International Chiefs of Police7 and a 192-city survey of (communications) interoperability conducted by the United States Conference of Mayors in 20048. However, these inventories have a much more limited focus and scope than ours. We anticipate setting up a mechanism by which our inventory can be updated to preserve its currency. This alone, we believe, is an important contribution, to practitioners as well as to academics.

A second contribution lies in our approach to describing and classifying PSNs, only the bare outlines of which we have discussed here. We expected to find, but did not, a clear consensus in the academic or trade literatures on the different types of PSNs or the important bases by which to distinguish them. We have created a wide array of clearly defined PSN descriptors to support future comparative analyses of PSNs and related initiatives in other domains of practice. We believe that this descriptive approach will be useful for other researchers interested in interorganizational collaboration or in ICT governance and management.

Finally, most studies of interagency collaborations, in the public safety or other domains, rely on single case studies or on a small number of cases [e.g., 12]. Our approach attempts to combine the in-depth analysis of richly characterized PSNs with a large sample, if not the entire population of, ICT-related interorganizational collaborations in the public safety domain. For these reasons, we expect that our exploration of PSNs, of which this paper is a preliminary report, will make a useful contribution to literature on digital government.

8. ACKNOWLEDGEMENTS

This research is being conducted as a collaborative effort under NSF grants NSF-0534889 and NSF-0534877.

9. REFERENCES


7 http://www.iacptechology.org/TechnologySurveys.html

8 http://usmayors.org/72ndAnnualMeeting/interoperabilityreport_062804.pdf


Figure 2: PSN Density by State
Figure 3: PSN Density at Local Levels (County, City or Metropolitan Area)
Figure 4: Total PSNs within States (Compiles Figures 2 and 3)
Figure 5: State Crime Rate (U.S. Census, 2000)
Figure 6: State Population Density (U.S. Census, 2000)