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The Diffusion of Information Technology in Policing[1]

by
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Abstract

This study examines the diffusion of innovation among municipal police departments in Northeastern Illinois. The opportunity to adopt an innovation arose when the Chicago Police Department (CPD) opened access to elements of its new centralized Data Warehouse to other criminal justice agencies. There is a long history of research on the diffusion of innovation, and a number of recent projects have applied this work to policing. Like innovation studies generally, this article presents the shape of the diffusion curve that describes the pace of adoption, and it examines factors associated with adoption and the extent to which the innovation was actually used. Adoption and extent of utilization proved to be largely independent processes. Involvement in cosmopolitan networks, experience with using databases for law enforcement, and the human capital capacities of the organizations influenced the adoption decision, while organizational resources and experience in using the system drove the level of actual use. The rapid growth of system utilization was apparently due to three factors: the active role played by the "evangelist" representing the host department; the fact that access to the system was free; and because it primarily empowered detectives – who enjoy a privileged position in policing – and did not challenge the traditional mission and organization of participating agencies.

Keywords: Police; Innovation; Information Technology; Organizational Change

The Diffusion of Information Technology in Policing

Introduction

This study examines the diffusion of an innovation in information technology among municipal police departments in Northeastern Illinois. The opportunity to adopt this innovation arose when the Chicago Police Department (CPD) opened access to elements of its new centralized Data Warehouse to other criminal justice agencies. The decision to open access to their system reflected the view that "crime has no borders," for potential offenders can move easily throughout the Chicago metropolitan area. The Data Warehouse is potentially a useful investigative tool. Through it, the CPD's partner agencies have access to the criminal history of past arrestees, outstanding warrants, the arrest status of juveniles, mug shots, digitized fingerprints, vehicle thefts, traffic violation convictions, and firearms data.

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The study treats adoption and utilization of the Data Warehouse by other police departments as an instance of the diffusion of innovation. There is a long history of research on the adoption of innovation. Some of the earliest studies examined decisions by individual farmers to adopt new agricultural technologies; more recently there has been research on the adoption of innovative policies by the American states, the spread of new consumer products via the marketplace, and methods of fertility control (Wejnert, 2002). A major synthesis of this research can be found in a book by Everett Rogers (1995) that serves as the sourcebook for work on the diffusion of innovation.

In innovation research, one of the first questions is, "What is the shape of the adoption curve?" Over-time adoption processes can be described by a cumulative frequency distribution that moves toward 100 percent as an increasing proportion of the target population adopts the innovation. Research on the diffusion of innovation suggests that this curve is almost always "S-shaped" (Grubler, 1996). That is, there is typically an early period during which a few innovators experiment with and adopt the innovation. Later, after these pioneers have demonstrated its utility and legitimated its use, there is a span of time during which use of the innovation spreads widely, and eventually it may become "mainstream." Still later, the rising adoption line typically flattens out, for the remaining "laggards" sign on only slowly. The success of an innovation can be judged by how quickly it moves to the take-off point at which it begins to enter the mainstream, by how long the mainstreaming process takes, and by the ultimate percentage of potential adopters who choose to get involved. A section of this report depicts the diffusion curve for the Data Warehouse, and compares it to others in the policing field.

At the level of the individual adopter, one research question is <u>where</u> each sits on the adoption curve – are they innovators, mainstream adopters, laggards, or resisters? This leads to the question of <u>why</u> they fall where they do on the innovation curve. Some of the factors that have been found to be involved in positioning the targets of an innovation diffusion curve are relevant to this study. Early adopters tend to be more tightly linked to regional and national networks that facilitate the exchange of information and confirm the suitability of innovations. In his seminal review, Rogers (1995) refers to participation in these networks as indicative of "cosmopolitanism," because the people in them are seeking new ideas from outside their usual round of contacts. He concludes cosmopolitanism is a common feature of early adopters of all kinds of innovations. This article documents that participation in cosmopolitan networks is linked to adoption of information technology in Illinois as well.

Another potentially important factor is resources, for organizations vary in their extent of financial and human capital. Research on innovation tends to find that non-adopters are resource poor as well as isolated from cosmopolitan networks. Mastrofski, et al (2003) find that sheer agency size facilitated the adoption of community policing. They argue that agency size measures the organizational capacity and slack resources that were available to push community policing projects along. They also found that funding by the federal Office of Community Oriented Policing Services advanced that agenda as well, as it channeled financial support for hiring additional officers to staff community policing programs. In addition to money, organizations also differ in the extent of their human capital. Some will have managers with sufficient vision to promote innovation, enough line personnel sophisticated enough to

appreciate new approaches to solving old problems, and enough well-trained people to make effective use of new technologies; others will not. Finally, innovations may spread rapidly because they obviously advance the formal mission and fit the informal culture of potentially adopting organizations (Wejnert, 2002). We raise this issue in the conclusion, where we speculate about the factors that might explain the rapid adoption of the Data Warehouse.

An issue posed by the literature on innovation is how it is precipitated and facilitated by external and internal factors. Political scientists studying adoption of policy innovations by the states frequently focus on the influence of political variables, such as inter-party competition (Berry and Berry, 1990). Along with many others, Zhao, Thurman and Lovrich (1995) concluded that police departments adopt community policing largely in response to external political pressures, for so popular is the concept that few police chiefs want to be without something they can point to as their program (Skogan and Hartnett, 1997). Martin (1990) found that cities facilitated the hiring of women officers primarily in response to legal pressure, in the form of expensive-to-settle civil suits. Weiss (1997) included measures of what he dubbed "risk mediation" in his model of innovativeness, to capture decisions made to reduce risk of civil liability. In this case, however, the adoption of an information technology initiative is not an issue which stirs much constituent passion or litigation, and we expect internal factors to be more important. Among these are the previous experiences agencies have had using databases and computers. In a review of innovation research, Wejnert (2002) identified familiarity with an innovation as one of the factors facilitating its acceptance.

This Study

This study examines the diffusion of technology use among a sample of 122 municipal departments. To encourage use of the Data Warehouse, the Chicago Police Department (CPD) named a technologically savvy retired police officer to serve as the Warehouse's "evangelist." He initially confined his attention to the criminal justice system in Cook County, Illinois. After a pilot test, he contacted every agency to describe the resource that was being made available to them – for free – and visited most jurisdictions to give a demonstration, distribute materials and answer questions. He described a system that is easy to access using a web browser and other familiar Internet tools. The Data Warehouse features an intuitive, web-like appearance and allows users to quickly search the CPD's deep databases using "fill in the blanks" forms on the screen. It can be accessed via high-speed Internet connections that already reach most justice agencies in Illinois. The CPD also offered free training for representatives from each participating agency, with the understanding that they would in turn train others in their jurisdiction. As detailed later, our interviews and observations highlighted the importance of the evangelist in speeding the adoption of innovation.

The CPD proselytizing efforts extended to all elements of the criminal justice system. Agencies as diverse as the county prosecutor, university police, local offices of the FBI and Internal Revenue Service, the Illinois State Police, regional 911 centers, probation and parol agencies, and even a public school system' security office quickly signed on. Later, participation in the program began to extend beyond Cook County. At the time this report was written more than 210 agencies of all kinds were using the Data Warehouse. This study is confined to one type

of agency, however, municipal police departments. They were selected because they share a common mission and organization, and they serve specific geographical areas for which census data and crime rates can be collected. They all record and investigate crime and arrest offenders. Outside of Chicago there are 122 such Cook County agencies, and in this study they constitute the "universe" of possible adopters. One goal of the project is to track the shape of the diffusion curve that characterizes the spread of innovation through this universe.

Archival data were collected on the agencies, and a survey was conducted of key informants concerning the decision to participate in the Data Warehouse. Data on system usage was drawn directly from the Warehouse itself. This article briefly describes the ways in which the system is used and trends in utilization over time. It's major purpose, however, is to explain variations in the adoption and extent of Data Warehouse usage. To do this we developed measures of organizational and community factors that past research suggested could either facilitate or discourage the adoption of innovations by police agencies. Researchers have explored the acceptance of innovations ranging from hybrid seed corn to digital television. However, compared to studies of producers or consumers of products in the private sector, there has not been as much research on the adoption of innovation by municipal government, and much less is known about why police departments choose to stray from the tried and true (Skogan and Frydl, 2003).

The Data

To gather some of the data required for this study, a telephone survey was conducted of all 122 potential users of the system. The questions asked of all agencies focused on their organizational and technological capabilities. Participating agencies were presented with questions about who was sent for training; obstacles they had to overcome to become users of the data warehouse; and their experiences using the system. All agencies were quizzed about the decision to participate. An advance letter to the chief of police for each agency explained the nature of the survey.

An important feature of the survey was that agencies were to be represented by <u>two</u> respondents rather than one, in order to more accurately represent features of the organizations. One respondent was to be the chief of police, and the other a person that he or she nominated in response to a question asking for " . . . another contact person within your department who knows about the Data Warehouse system and could provide us with detailed information about the use of the Data Warehouse in your agency." After follow-up letters and calls, the eventual agency response rate was 97 percent for the chiefs, and 92 percent for nominated experts. Sometimes we were able to interview the local Data Warehouse expert but not the chief, so overall the survey represented 98 percent of the sample agencies. For many questions, the responses of the chief were used to represent the organization. This was especially true for the first part of the questionnaire, which focused on policy issues and features of the organization. For these questions, answers from the secondary respondent were used if the chief did not know the answer but the follow-up respondent did. The responses of many other questions could be combined directly, for the study was designed to use each of two respondents as independent reporters. Because the two respondents saw their department from different vantage points, with

the lower-level experts being much closer to day to day operations, they each had unique information to supply. When the same questions were asked of both respondents, reliabilities (Cronbach's alpha) ranged from the .70s on questions about system use to the .80s on agency characteristics.

Past research indicates that innovators are linked to other innovators and to the progressive policy community that is associated with their industry. To measure this for police departments, we independently secured membership information from some of the leading practitioner groups that foster innovation in policing. Cosmopolitanism was indexed by a department's association with the Police Executive Research Forum (PERF), the International Association of Chiefs of Police (IACP), the International Association of Law Enforcement Planners (IALEP), and the Illinois Police Chiefs Association. Being a CALEA-certified department was another indicator that an agency was part of the progressive network linking many police departments. The Commission on Accreditation for Law Enforcement Agencies is a voluntary accreditation for law enforcement agencies based on a body of standards internationally accepted by the law enforcement community.

Other information was collected from archival sources. Not one of the agencies in this study submitted their crime data for the FBI's Uniform Crime Report (Illinois' UCR system has collapsed), but recorded crime data for all of them were found through the Illinois State Police or by telephone calls to the agencies themselves. The 2000 Census was the source of information about the size and composition of the departments' jurisdictions.

As noted above, data on actual use of the Data Warehouse was extracted from the system itself, which is configured to log the origin of each database query. CPD technical staff periodically generates a report on system use and we organize the data for statistical analysis. System usage is measured here by the monthly number of database queries made by each participating agency. For example, a user might start an investigation by typing in the nickname of a possible suspect. They could follow up on the response by requesting a mug shot, which can be accomplished by simply clicking on the name of any of the individuals identified by the nickname search. This would be counted as two queries by the system. Unique among diffusion studies of policing, there are two dependent variables in this study: whether or not agencies signed on and used the Data Warehouse, and the extent to which they used it. Both measures were derived from query counts.

Our objective measure of the adoption of innovation is another of the unique features of this study. Past studies of the diffusion of innovation in policing (Weisburd and Lum, forthcoming; Weisburd, et al, 2003; Mastrofski, et al, 2003; Kraska and Kappeler, 1997; Weiss, 1997) have relied on reports gathered by questionnaires mailed to samples of police departments. For example, in their 1999 survey Weisburd, et al (2003) asked respondents to recall the year in which their department adopted various Compstat-like managerial arrangements, and some set that date as far back as the 1980s, before New York City's program appeared on the scene. Mastrofski, et al (2003) asked whoever was assigned to complete their questionnaire dozens of specific questions about department policies and practices; for example, if they "engage in public space cleanup," and if they worked with Neighborhood Watch groups.

The validity of such survey recall reports (the extent to which they reflect reality) is unknown, and the reliability of individual measures (if two observers of the same organization would report the same facts) has been shown to be suspect. In his study of the diffusion of innovation, Weiss (1994) distributed questionnaires to five different representatives of the same police organizations, and found substantial disagreement between them on such basic issues as whether or not they had adopted any of a list of programs and technologies. He resorted to a complex confirmatory factor analysis of the data in order to tease out evidence of the underlying, "unobserved" correct answers. The validity and reliability of mail surveys of police organizations is an important issue, given their importance in studies of the criminal justice system (Maguire, 2002). A recent report of the National Research Council calls for a careful assessment of the validity and reliability of agency surveys (Skogan and Frydl, 2004). In this case, software monitoring the log-on identification numbers assigned by participating police departments to their individual users provides an objective measure of their actual behavior.

Trends in the Adoption of Innovation

Beginning in October 2002, the CPD moved beyond the original pilot departments and began to train agency representatives to use the Data Warehouse. The three-hour, hands-on training sessions were conducted at police headquarters. During the period considered here Chicago police trained several hundred representatives of suburban Cook County police departments alone. The average department sent two people to be trained, and as many as five appeared from a single department. Most sent detectives or patrol officers. The actual number of system users in these suburban departments is much greater, however. Access to the Data Warehouse follows a "train the trainers" model. That is, agencies were encouraged to send just a few key personnel to be trained at Chicago police headquarters. They were expected, in turn, to take responsibility for training other users in their own departments. In the agency survey, 92 percent of participating departments indicated that they had already done some in-house training, greatly multiplying the number of individual users of the Warehouse.

********* Figure 1 goes here *********

Figure 1 presents two views of the expansion of Data Warehouse usage. The left panel illustrates how many suburban departments were using the data warehouse. It depicts the number of <u>new</u> users each month (the dotted line on the left-hand axis) and the <u>total</u> number of agencies using the system at that point (the solid line on the right-hand axis). Twenty-eight agencies had been trained and were using the system within three months of the beginning of the initiative, and 63 agencies were involved within six months. In the peak month for new adoption as many as 13 agencies gained access to the Data Warehouse for the first time. Later, new adoptions began to fall as the pool of non-adopters shrank. After 19 months, 108 of 122 Cook County police departments were using the system.

The right panel of Figure 1 traces trends in the adoption of this innovation by tracking the volume of system use. Both monthly usage (the dotted line on the left-hand axis) and cumulative total use of the system by suburban police departments (the solid line on the right-hand axis) are

presented. In the first four months the relatively small number of new users had "hit" the system more than 10,000 times, and the 97 agencies that were using it at the twelve-month mark had made a total of about 109,000 queries. The peak month of use was the last one in the series, March 2004. In that month, police departments in this study issued nearly 30,000 queries, and overall they had made more than 267,000 inquiries.

Extent and Timing of Adoption

Figure 2 presents data on the number of participating agencies in another way, drawing the "diffusion curve" for this universe of police departments. It presents the cumulative, over-time percentage of Cook County agencies using the system each month. As the curve approaches the top of the vertical axis near the end of the study period, it levels off at just under 90 percent.

********* Figure 2 goes here *********

As noted earlier, research on the diffusion of innovation suggests that this curve should be "S-shaped." A period of gradual adoption by a few early innovators should be followed by a "mainstreaming" period, after which the curve should flatten. In contrast, actual buy-in to the Data Warehouse initiative was strikingly rapid about 18 months.

Grubler (1996; 1991) addressed the issue of the speed of diffusion processes by proposing a benchmark: the time period that it takes for an innovation to spread beyond the first 10 percent of adopters, to be embraced by 90 percent of potential adopters. That time span, which Grubler dubbed "delta t," is also depicted in Figure 2. Grubler finds that innovations span delta t at different rates. He grouped innovations, and the low and high range for their delta t's was 15-30 years. For example, the network of shipping canals in the United States grew from 10 percent of its eventual maximum length to 90 percent over the course of 31 years, so that is its delta t (Grubler, 1996).

Benchmarks against which diffusion of the Data Warehouse can be contrasted can be found in studies of other innovations in policing. In the Compstat study described earlier (Weisburd, et al, 2003), the beginning of the innovation period was defined by the emergence of the first Compstat-like management accountability systems in the early 1980s. The early-adoption stage for this managerial innovation was an extended one, and it was not until the publicity associated with New York City's management model began to circulate more than a decade later that the adoption rate for management strategies with Compstat-like features reached the ten percent threshold. At the time they collected their data adoption had not yet hit 90 percent, but based on their national survey of police departments, Grubler's delta t period for Compstat-like management innovations was estimated to extend from 1996 to 2006, or ten years. They conclude (p. 433) that Compstat ". . . would rank among the most quickly diffused forms of innovation." In their study of computerized crime mapping, Weisburd and Lum (forthcoming) again estimate (for market penetration had not yet hit the 90-percent mark) that delta t for crime mapping will be somewhat less than 15 years. Similarly, Kraska and Kappeler (1997) surveyed departments with 100 or more sworn officers, in order to examine the spread of specialized SWAT teams. These teams first appeared in the 1960s, and they began to grow in popularity

beginning in the late 1970s. Their survey documented that almost 90 percent of departments in this size range had adopted SWAT by 1995. Klinger (2003) used their data to calculate that this "militarization" of American policing (as Kraska and Kappeler dubbed it) had a delta t of about 25 years.

What are the factors associated with sending officers to training, connecting to the CPD via the Internet, and beginning to use the Data Warehouse? The findings are summarized in Table 1, which documents differences between adopters and non-adopters, and the statistical significance of those differences.

One of these is involvement in cosmopolitan networks. Mastrofski, et al (2003) found that one factor speeding the adoption of community policing was association with the Police Executive Research Forum (PERF), which falls in this category. In a study of the diffusion of computerized crime mapping, Weisburd and Lum (forthcoming) report that early adopters were more likely to use list serves, attend conferences, and purchase books on the topic, and they were more likely to characterize themselves as consumers of research on crime hot spots. Weiss (1997) found a strong direct effect of cosmopolitanism (indexed in part by the chief belonging to PERF, the agency being accredited, and a staff member belonging to a planning association) on the adoption of innovation. He also identified an additional, indirect effect of cosmopolitanism through the tendency of networked organizations to actively gather information from other police departments and imitate their successes. He dubbed this "peer emulation."

********* Table 1 goes here *********

As anticipated by this research, being linked to cosmopolitan policing networks that promulgate innovative ideas was one of the factors linked to the adoption of information technology as well. For example, either the chief or a senior staff member was a member of PERF in 15 percent of the adopting agencies, and almost one-quarter of adopters were CALEA-certified agencies. The IALEP planning association is a small body, but 8 percent of adopters employed a member of this group. Many chiefs belonged to the Illinois Police Chiefs Association, but significantly more were found among adopting agencies.

Among the internal factors affecting adoption was the base of experience on which agencies could draw when choosing to participate. Adopters were much more likely to already be users of databases and data sharing arrangements. This was measured by whether they were collecting the additional crime data required to be a NIBRS-compliant agency. A second measure of experience was whether their agency participated in Cook County Sheriff's Criminal Apprehension and Booking System (CABS), which enables police to quickly identify criminal suspects through a uniform arrest booking system. The influence of these factors is described in the "experience as data user" section of Table 1.

The agency survey also gathered data on the computer technology that the agencies needed and could afford. As Table 1 documents in the "computer savvy" section, adopting agencies were also already better equipped with computer hardware, measured here by whether patrol vehicles were equipped with portable data terminals and if officers used laptop computers.

Adopting agencies were also more likely to report that they regularly conducted training for their officers in how to use computer equipment and software, and they provided their officers with e-mail addresses. The influence of an organization's human capital was assessed using the percentage of its officers with a college degree. Departments with more college graduates were significantly more likely to be an adopting agency.

Community factors were also related to the adoption of innovation. Of the 14 non-adopting agencies, six were predominately African-American in composition, and two more had large Hispanic populations. Except for one small agency in a high-status suburb, the remainder were white working-class communities, home to people of modest means. Non-adopting communities averaged less than 10,000 residents in the 2000 Census. Overall, they all had relatively high crime rates; as documented in Table 1, the personal crime rate was more than four times higher than that for adopting agencies. However, many small, struggling communities with high rates of crime did sign up, and we shall see below that the effect of the community factors presented in Table 1 disappear when those nearer the top of the list are taken into account.

Many of these factors were also related to the speed with which agencies adopted the Data Warehouse. We have not emphasized differences in the timing of adoption because of the short time-span in which adoption approached the 90-percent threshold. However, agencies that were experienced data users, belonged to cosmopolitan networks, were savvy computer users and counted a larger percentage of college graduates in the ranks were also somewhat more likely to be "early movers."

What was not related to the adoption of innovation? One factor mentioned in the literature is Weiss' peer emulation. We measured this in the survey with questions about the frequency with which departments contacted others for information, and also included a question about how frequently our responding agencies were themselves contacted by other police departments. There was not much variance in their responses. More than 95 percent of departments reported contacting others at least once a week for information, and all but one of the responding agencies indicated that they themselves received these kinds of inquiries. In addition, the extent to which departments employ civilian staff is sometimes used as an indicator of department modernity, but that factor was unrelated to Data Warehouse access. Finally, the survey asked whether agencies had applied for COPS-MORE grants, which are federal awards to support information technology applications in policing. Many had, but this factor was unrelated to whether or not they participated in the Data Warehouse initiative.

Volume of Use

Most studies of the diffusion of innovation in policing are confined to dichotomous, "adopt or not" decisions by police agencies. (An exception is Mastrofski, et al (2003), which develops a measure of the extent to which departments have adopted community policing.) However, the extent of adoption is the more important measure of its impact on actual operations. This is best measured by the extent of system use, rather than by just whether anyone is using it at all. The Data Warehouse yields a direct measure of the extent of adoption, among those who did so. There was tremendous variation in the extent of "operational" adoption of the

Data Warehouse. Among the 108 adopting agencies, average monthly use ranged from two to more than 3,500 queries. The bottom 20 percent of agencies used the Data Warehouse an average of 45 times per month, while the top 20 percent averaged 220 times per month.

What were they using the system for? The user survey quizzed chiefs and their Data Warehouse expert about the uses their officers were making of the system. They reported that it was being used most frequently to look at mug shots (83 percent of agencies), check criminal histories of suspects (79 percent), make address checks (81 percent), and check for outstanding warrants (68 percent).

Figure 1 illustrated trends in system use over time. As the number of participating agencies expanded, system use naturally grew. By the end of the study, the 108 participating suburban police departments were issuing almost 30,000 Data Warehouse queries per month. One important determinant of volume of use was experience. The longer departments used the system, the more they used it each month. In November 2002 (the third month of this project) the 23 participating agencies made an average of 113 queries each. By March 2004, the 108 participating agencies made an average of 275 queries each. At the end, departments that had been using the Data Warehouse less than six months made an average of just 86 queries each month, while those who had been using it more than a year were making more than 230 queries each month. The agency-level correlation between the average number of queries they were issuing per month (logged, because it was very skewed) and their months of experience with using the Data Warehouse was +.45. However, this was in part because larger jurisdictions tended to have begun participating sooner. Larger places have more crimes to be investigated, and more staff who can make use of the Data Warehouse, so it is also important to control for jurisdiction size. In the statistical analyses that follow, system use will be measured as the average monthly use per 10,000 residents, to account for this factor. By this measure use of the Data Warehouse was still skewed, for some departments were much heavier users than others. As a consequence, the logged rate will be used in all analyses.

Using this population-standardized and logged measure, system use appears to be driven by both internal and external factors. The heaviest users proved to be departments with more resources that were facing higher rates of crime. The survey and archival sources contributed information about police agency staffing and budgets, and both were linked to higher levels of system use. Data Warehouse use rates were correlated +.50 with department expenditures per capita, and +.51 with the number of sworn personnel per capita. Only 90 responding agencies could come up with figures about the size of their computing budget, and in this group the correlation of per capita expenditures with system use was +.33. The Part I crime rate for these jurisdictions was correlated +.39 with Data Warehouse use; the more business they had, the more they were using the system. Of course, none of these factors was independent of the other. Police department budgets are heavily loaded by staff salaries, and in this case expenditures were correlated +.74 with staffing levels. Places with more crime spend more on policing, and department strength was correlated +.70 with the crime rate.

Finally, there continued to be an effect of experience with using the system. The zero-order correlation between months of system usage and Data Warehouse use was only +.19, but in

the multivariate analysis that follows, experience proves to have an independent effect on the volume of system use. The longer departments used it, the more they made use of it.

Multivariate Analysis

We have seen that one set of factors is associated with the adoption of innovation and another set is associated with the extent to which it is used. Adoption was linked to innovative networks, experience, computer savvy, and the human capital available to these departments, while use was largely a function of the extent of crime and the resources available to make use of this law enforcement tool. Adoption and use may thus seem to be independent processes, but the two are also linked by the fact that the extent of use can only be examined among adopting departments. We can only observe the extent of use among participants who have selected themselves by adopting the innovation; for the others, use is unobserved. The Heckman (1979) approach to this problem is to break it into two parts. The first step in understanding the adoption process is to model the dichotomous "yes-no" adoption decision using a multivariate probit. This analysis parcels out the independent effects of adoption-related factors. In addition, this step yields a "selection hazard" measure that then enters into the second step, which is a regression analysis of factors associated with the extent to which the innovation was actually used. The selection measure (technically, the Inverse Mills Ratio) corrects this second-stage analysis for the selection bias associated with the selectivity involved in the first-stage adoption decision. The result is a set of unbiased multivariate coefficients that capture both aspects of the diffusion of innovation being examined here.

The analysis uses indices developed from the measures presented individually in Table 1. The cosmopolitan network measure sums for each agency the number of memberships listed there, including IALEP, PERF, the Illinois Police Chiefs Association, and CALEA accreditation. The measure of database experience combines CABS participation and whether the agency is NIBRS compliant. Computer savvy is measured by responses to questions about department hardware, software and training.

********* Table 2 goes here *********

Table 2 presents the results of the analysis. One column depicts correlations between the two adoption measures (adopt-or-not and log monthly per capita use) and factors that were hypothesized to be associated with them. The right-most column reports the results of the two-step selection analysis, which was conducted using the Heckman Selection Model, Probit and Regression modules of Stata Version 8. The predominate factors explaining the adoption decision were involvement in cosmopolitan networks, prior experience with investigative databases, and the organization's human capital, measured by the percentage of officers with a college degree. As anticipated, these were all "internal factors" characterizing the experience and capabilities of the organizations, not "external" factors having to do with their workload or environment. Computer savvy, which had a strong zero-order correlation with adoption, was not independently related to signing onto the Data Warehouse, once those factors were taken into account. The pseudo R^2 for this equation indicates that these three factors explain almost 50 percent of the adoption decision.

The factors associated with use of the innovation were resources and experience. Even in the multivariate model, the more months that the agencies had been using the Data Warehouse the more intensively they used it, measured by queries per capita. Larger departments (again per capita) were also more intensive users, perhaps because they had more slack resources to devote to this new venture. The crime rate was not significantly related to the volume of Data Warehouse use once experience and size were taken into account. Together, resources and experience explained 27 percent of the variance in Data Warehouse use. The Wald X^2 is a test of the overall significance of the model (it is equivalent to an F-test in regression) and it is highly significant.

Table 2 also documents the importance of considering adoption and use as a two-stage process. If the adoption decision and the extent of actual system use are related to the same factors, then differences among police agencies related to selection could seriously bias the second step of the analysis. If, on the other hand, one set of factors affects the decision to participate, and another the extent to which agencies participate, the two can be considered unrelated processes. The Rho statistic, which is presented in Table 2, indicates the strength and direction of the relationship between the two equations; it is the correlation between the errors (the unexplained variance) in the two models. In this case rho was not statistically significant different from zero. There was no crossover between the independent variables; those associated with adoption were not independently related to extent of use, and vice versa. Networks, database experience, and human capital factors strongly influenced the adoption decision, while resources and experience with the system drove the actual use of this innovation.

Conclusion and Discussion

An important difference between this and other studies of the diffusion of innovation is the size of the jurisdictions involved. As a group they look somewhat diverse, because many of the older, inner-ring communities surrounding Chicago share an affinity with the city neighborhoods from which many of their residents came. However, on average these suburban communities were home to only 24,500 residents. More typical is Weiss' (1997) study of diffusion, which involved only departments serving cities of 100,000 residents and larger. In this size range they were probably all large enough to support an elaborate organizational structure, including specialized research and development units, and in these times they would probably all have specialized information technology support units. The agencies involved in this study, on the other hand, employ generalists and not many specialists. Communities with relatively large police forces used the Data Warehouse more, and they had the people to do so. Many of these suburban jurisdictions also do not have extensive information systems. But while this is a study of diffusion of innovation in smaller departments, agencies like them constitute the majority of police organizations in the country.

Why was the diffusion curve for these communities virtually a straight line pointing upward for so long? An important reason for the rapid early diffusion of Data Warehouse use was probably the role of the "evangelist." Some innovations in policing do not have anyone playing this role. The spread of Compstat-like management strategies is in this category, although to a certain extent the media played this role once New York City's publicity machine got involved. Wejnert (2002) identified knowledge about a proposed innovation as one of the factors speeding innovation. However, while Weisburd et al (2003) report that awareness of Compstat was very high, it was above 90 percent even among departments who by 1999 had still not gotten involved. This indicates that the decision to adopt an innovation is not just dependent on awareness. Computerized crime hot-spot mapping also has cheerleaders. The hardware and software vendors who stand to gain from its adoption push their products aggressively, and NIJ supports a crime mapping center dedicated to advancing the use of this technology. Community policing enjoyed the support of a vast network of academics, consultants, policing intellectuals, grassroots community organizations, and government agencies, and they pushed their vision for policing aggressively as well (cf., Skogan and Hartnett, 1997). Marketing matters in the public sector as well as in the private sector.

It possibly mattered that the "evangelist" was from close by, and he was not selling a product or asking for user fees. As a retired Chicago police officer still working for his department he had high "source legitimacy" in describing his wares and their potential utility. In the 1970s and 1980s, American police departments were convinced by vendors to spend hundreds of millions of dollars computing, but by the beginning of the 21st Century the hardware for this project was cheap, the database software resided on the Warehouse, and the data itself was already being used to good effect by Chicago police officers. The rapid pace of adoption may have also been encouraged by the geographical propinquity of these agencies. As noted above, they are in frequent contact with one another and belong in part to the same

associations. National diffusion processes may more normally take the shape of a curve, for distance learning is called for.

The cost of the system was also doubtless important, for "free" is an attractive price point. One section of our survey of system users presented a checklist of reasons that they might have considered when deciding to get involved, and the number one reason was that it was available at no cost. Fully 88 percent of participating agencies reported this was "very influential" and another 8 percent that it was "somewhat influential" in their decision. Mastrofski, et al (2003) found that financial support from Washington, D.C. was influential in encouraging agencies to adopt elements of community policing, and the possibility of federal aid also affected the support of police chiefs for the project. But money is not everything in policing. In their Compstat study Weisburd, et al (2003) note that this managerial revolution is sweeping American policing even though it is not backed by external financial support. In our agency survey, other important influences mentioned by respondents were the perception that the system would help identify offenders coming from the City of Chicago (76 percent indicated this was very influential), that it provided them with an opportunity to improve their officers' skills (73 percent), and that there was enthusiasm among the staff about participating (67 percent). Interestingly, they did not report being motivated by their standing among their peers. Moore (2003) notes that organizations adopt "best practices" and other modern ideas in part to court legitimacy and to enhance their standing among peer agencies. In this case, only 37 percent of agencies indicated that standing among their peers was an important reason for getting involved, the least frequent response.

Another important feature of this innovation is that it's adoption did not call for any difficult and risky organizational changes. A serious community policing program, to take another example, is potentially destabilizing. It calls for adopting departments to change their relationships with the general public, take responsibility for a host of new community problems, and rethink the relationship between downtown managers and rank-and-file officers (Skogan and Hartnett, 1997). Crime mapping is supposed to enable officers to discern the problems underlying concentrations of the icons marking crime incidents, but this is often new and hard for them. The Warehouse is not destabilizing; to the contrary, it turns out that the most intensive users of the Data Warehouse are detectives, who already enjoy a privileged place in policing agencies. Departments sent twice as many detectives for training as they did any other type of employee. In this sense, the use of investigative technology is like Compstat; Weisburd, et al (2003) attribute its rapid diffusion in part to the fact that it focuses energy on the most traditional goal of police organizations – crime fighting – and works through its traditional command-and-control hierarchy. Technological support for criminal investigations may likewise be a stabilizing rather than destabilizing force, and may help preserve a traditional model of policing that had been under attack by reformers for several decades.

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Table 1 Factors Associated With Adoption of Innovation

Percentages	Non-adopters	Adopters
Cosmopolitan Network		
IALEP member	0	8 *
PERF member	0	15 ***
CALEA certified	0	23 ***
IL Chiefs member	79	94 ***
Database Experience		
CABS participant	29	90 ***
NIBRS compliant	15	42 ***
Computer Savvy		
PDTs in cars	71	98 ***
Use portables	29	58 ***
E-mail for officers	29	75 ***
In-house training	57	80 ***
Human Capital		
Officers college grads	20	37 *
City Environment		
Average population	9,393	22,546 **
Percent African-American	37	15 ***
Personal crime per 10,000	141	32 ***
Number of agencies	14	106-108

Note: N=106 for survey measures; N=108 archival data.
***=p>.001; **=p>. 01; * p=>.05

Table 2 Adoption and Use of the Data Warehouse

Heckman Selection Model	zero-order correlation	coefficient estimates[a]
Adoption model -adopt or not		
Cosmopolitan network	.24 *	1.09 *
Database experience	.47 **	1.61**
Human capital	.29 *	.03 *
Computer savvy	.43 **	–
Constant		-2.41**
(Pseudo $R^{2)}$		(.48)
Usage Model -log average monthly use per 10,000 residents	.51 **	6.7 **
Officers per 10,000	.19	.05 *
Months of experience	.39 **	–
Part I crime rate		3.41 **
Constant		(.27)
(R^2)		
rho		.60
Wald X^2		46.2 **
(number of cases)	(120)	(120)

[a] reduced form equations; significant coefficients only.
*= $p \leq .05$; **=$p \leq .01$

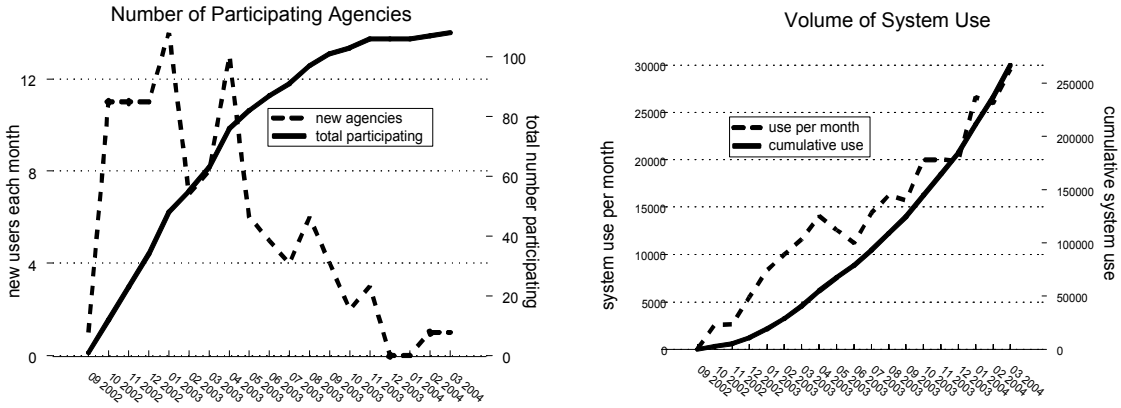

Figure 1 Trends in the Adoption and Use of Innovation 2002-2004

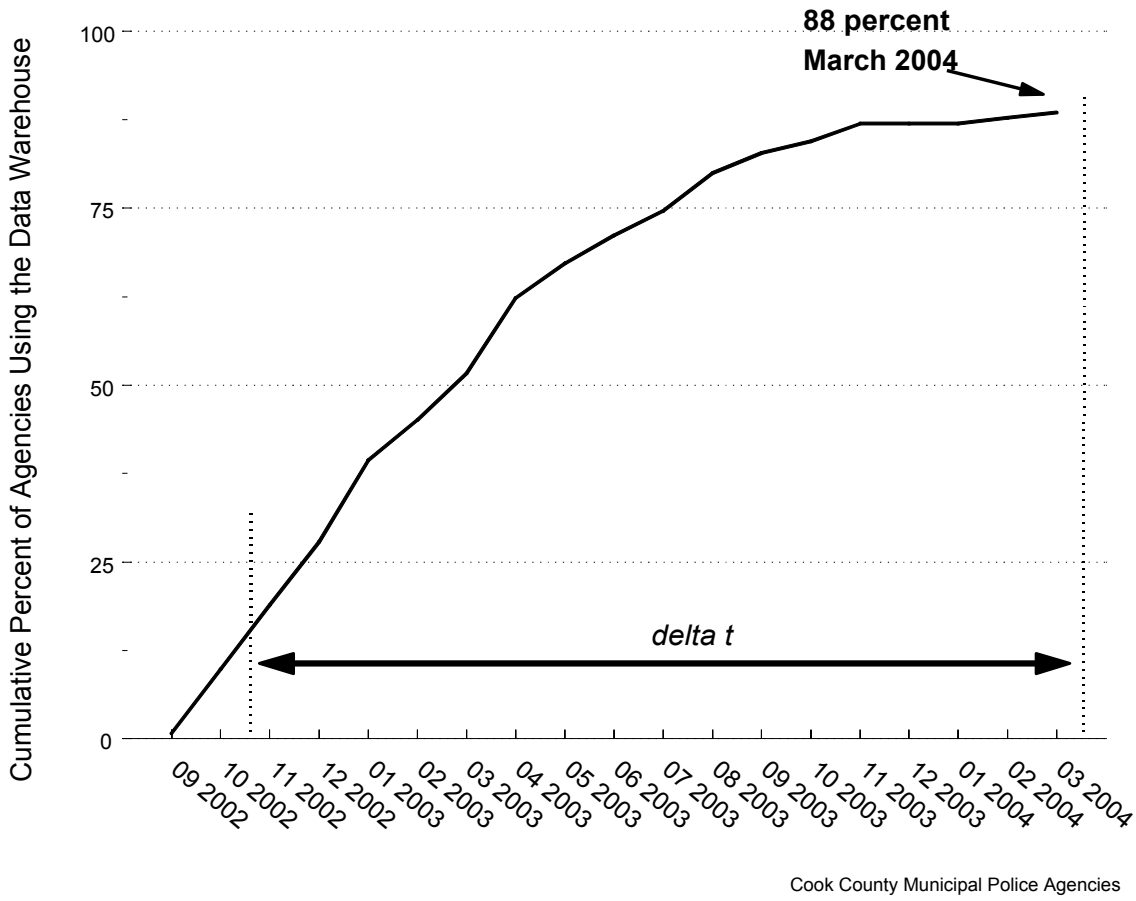

Figure 2 Diffusion of Information Technology as an Innovation