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Research Article

Organizational Correlates of Technology Adoption in Municipal U.S. Police Departments

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Abstract: This paper examines the organizational and environmental correlates of the adoption of various technologies among 951 municipal police departments in the United States. Using data from the 2016 Law Enforcement Management and Administrative Statistics (LEMAS) survey, multiple regression models are used to predict measures of police organization, structure, context, and culture on police technology adoption. Several different models, derived from factor analyses, are used to inspect the different kinds of technologies used in law enforcement. The results show that while technology has become increasingly widespread in law enforcement, there are still areas for advancement. In particular, there are important differences in the adoption of certain technologies based on the differences in the technologies themselves, as well as the differences in the implementing police departments. Evidence of a resource gap between large and small police agencies is also observed. Implications for policy and future research are discussed.

Keywords: Policing, Police innovation, Police organization, Police technology

Introduction

Technology has had a large impact on the development and evolution of American policing. The rise of the automobile and two-way radio transformed police departments in the early 20th Century as motorized preventive patrol became the main strategy for crime prevention and response.[1] In 1967 the President's Commission on Law Enforcement and Administration of Justice (LEAA) called for "the rapid adoption of information technology to improve the effectiveness, efficiency, and fairness of the criminal justice system".[2] Vast sums of money in the form of police expenditures have been spent on technologies meant to improve police research, equipment, and training since then.[3],[4] While research has found that technology does not always increase police effectiveness, the number of technologies implemented in policing are numerous.[5] Some examples include computerized record systems, body cameras, gunshot detection systems, license plate readers, GPS systems, and social media. These technologies have become increasingly widespread in modern law enforcement, though they are by no means the only ones. The decision of which technologies to adopt is often a difficult one for police executives as law enforcement agencies are often understaffed and underfunded.[6],[7] Therefore, understanding the factors that contribute to whether or not a police department deploys technologies, and which technologies are chosen to be implemented, is important. This analysis examines the organizational and structural factors that influence the degree to which a department is technologically innovative.

Most scholars that conduct research on policing and technology have examined the relationship between the adoption of technologies and police effectiveness, which is usually measured as lowering crime, or if these technologies improve police efficiency, which is typically measured as increasing response time to calls for service. [8],[9],[10],[11] There are a few studies that have analyzed the organizational factors that inform technology adoption among police departments. However, these are mostly qualitative in nature and only examine a handful of agencies.[12] This study contributes to the literature by examining the relationship between police organization and technology adoption quantitatively using a nationally representative sample of municipal police agencies in the United States.

Police Organization

Police behavior is affected not only by individual-level officer characteristics, but also by police organization.[13] Police organization has been used to study several different outcomes including police use of deadly force, police expenditures, and police policy.[14],[15],[16] In these studies police organization is often conceptualized as the bureaucratization and professionalization of a police department, department size, departmental rotations, levels of oversight and departmental policy.[17] Policing scholars have examined the organizational structure of police departments for decades.[18],[19],[20] Maguire[21] proposed an influential theory of police organizational structure, where he argues that the three pillars of police organization are organizational context, organizational complexity, and organizational control. In addition to these three factors, research has also suggested that professionalization is an important component of

police behavior[22] and that organizational culture plays an important role in technology adoption. A discussion of how these concepts relate to technology adoption and deployment in policing will now commence.

Organizational Context

Organizational context refers to factors such as organizational size and the organizational environment, like operating budget and the number of calls for service a department has to respond to. A variety of studies describe the relationship between the organizational structure of police departments and policing outcomes.[23],[24],[25] Department size is generally measured as the number of sworn officers employed by a police agency.[26] Organizational context is important because department size has been shown to condition the effects of several variables in policing.[27],[28]

While police agencies in large metropolitan cities typically don't lack resources[29], the same cannot be said for police departments in small towns and rural areas, who usually have small operating budgets[30], which prevents them from being able to afford to purchase and maintain information technology innovations that often have expensive end-to-end lifecycle costs.[31] In addition to sometimes being underfunded, policing agencies can also be understaffed. This can represent another obstacle to implementing technological innovations as some police departments may not have the manpower required to manage and use complicated technologies effectively.

Organizational Complexity

Policing scholars have theorized that elements of complexity are linked to police performance as well. As the primary motivation behind implementing technologies is improving efficiency and effectiveness,[32],[33] a police agency's level of organizational

complexity can be influential in its capacity to adopt technologies. Complex police organizations that utilize more civilians, have to cover larger geographical areas, and have more specialized units may have a need for technologies that other police agencies wouldn't.[34] For example, the more numerous and various types of the data that a police agency collects, more numerous types of records management systems (RMS) are required.

Organizational Strategies

The strategies enacted by a police department can also affect how and whether it implements different technologies. One of the most prolific and influential strategies employed by police agencies is community-oriented policing (COP). Key elements of COP include the adoption of a problem-solving approach, working with community members to solve issues related to crime and disorder, and using departmental resources (including technologies) proactively.[35],[36],[37] Lum, Koper, and Willis (2017) found that how technology is framed by a police department has a large impact on the degree to which a technology innovation will be used by officers. This framing is heavily influenced by the goals and strategies that are valued by a police department; those departments that stress traditional and reactive policing methods often view technological innovations as unnecessary, time-consuming, or even disruptive to their work. Conversely, police departments that place an emphasis on community-oriented policing, which relies on more proactive and problem-solving approaches view technology more positively, which causes officers to put more time and effort into learning and using innovations. Frames can work to enhance or limit the impact that

technological innovations have and this can discourage a department from implementing technologies in the future.[38] While scholars have found that police culture can differ in numerous ways,[39],[40],[41] the cultural climate within a police department can also influence the number of technologies that are adopted as research has shown that organizations choose to implement strategies and policies that are consistent with their prior organizational direction.[42],[43],[44]

Professionalization

Many studies of police behavior have focused on the professionalization of police departments. Professionalization has historically been measured by the number of hours of training required for new recruits, educational requirements, and hiring practices. Officers in more professional departments are likely to have received more education, more training, and to have shown that they possess the traits necessary for police officers to do the job asked of them in a principled manner. Professionalization can affect technology adoption as more complicated technologies require technical training and education in order to be used effectively.[45] Thus, more professional departments should be better suited to implement available technology innovations.

Current Study

This study aims to link police organizational factors with police technology adoption using quantitative methods. Although much has been gleaned from prior qualitative research on this topic, conducting quantitative research provides several advantages. This includes being able to use a larger sample size and an increased generalizability of the findings.[46],[47] Using measures of organizational context,

organizational complexity, community-oriented policing, and professionalization, this paper examines whether these processes affect the number of technologies that are implemented by police agencies in the United States. While prior studies have analyzed the impact of organizational structure on technology adoption among a handful of departments, this study uses a nationally representative survey that collects data on police organization and technology deployment to analyze this relationship. As the decision to adopt technologies is primarily an organizational one, variables measuring organizational context, complexity, and professionalization, should influence technology adoption. However, all technologies are not created equal and the challenges in implementing them can vary considerably. For example, installing a computerized file system is much easier than a gunshot detection system or a ballistic imaging system. Prior research has emphasized the multidimensionality of police innovations.[48] To account for this, factor analyses are conducted to determine the differences in the various technologies that are implemented by law enforcement. Multiple regression models are run on the factors that were revealed to examine whether or not different organizational factors predict certain technologies in different ways.

Data and Sample

This research study examines the relationship between organizational structure and technology deployment in municipal American police agencies. The study uses data from one source: the 2016 Law Enforcement Management and Administrative Statistics Survey (LEMAS). LEMAS comprises survey data about police departments' organizational characteristics from a nationally representative sample of U.S. law

enforcement agencies, making it the ideal data source to use for the present study. LEMAS has been used extensively in the literature to explore various technologies used in policing.[49],[50] The analysis includes all municipal police departments in the United States that served a population of over 10,000 people with LEMAS data in 2016, omitting those with missing data for the variables in the analysis. The original dataset, which merged data with the 2016 LEMAS and 2016 Census surveys, contained 2,784 police agencies, of which 2,135 were local police departments. All 600 sheriff's offices and 49 state law enforcement agencies were excluded from the analysis. There are known problems with sheriff's offices and LEMAS data, notably how difficult it is to parse-out the population served by a county sheriff's office from the local agencies nested within that county. Furthermore, scholars have argued that sheriff's offices and highway patrol agencies are substantively different from municipal police agencies and they have different goals, functions, and environments that make it difficult to compare them to one another.[51],[52] Similar reasoning is used to exclude local departments that operate in jurisdictions with populations of less than 10,000 people: the contexts these departments operate in are very different and make it hard to draw any substantive conclusions from. Prior research on police agencies has typically focused on larger departments in cities with populations of 50,000 or greater or 100,000 or greater. However, research has shown that important organizational differences exist between large-city police departments and small-town ones. In order to account for this, the present study also examines agencies that operate in communities of 10,000 or more.

After excluding the local agencies that operated in communities of less than 10,000 people, the sample contained 977 agencies. Of these 977, 26 had missing data on at least one of the variables included in the analyses and were dropped, resulting in a final sample of 951 municipal police departments. Chi-square tests indicated that the missing variables for these 26 agencies were not related to the values of the other agencies. For the analyses conducted in the study, the 951 departments are further separated into three categories based on the population of the jurisdiction they serve. The first is departments serving a population of 100,000 or more; there are 269 such agencies and they are responsible for serving over 97 million Americans. The second category is departments that serve a population between 50,000 and 99,999; there are 242 such agencies and they serve roughly 18 million people. The third category is made up of departments that serve a population between 10,000 and 49,999; there are 440 such agencies and they serve over 10 million citizens. Together, the 951 departments in the sample serve roughly 125 million people in the United States.

Dependent Variables

The agency-level outcome of interest in this study is the number of technologies adopted at the time of the survey. After examining the LEMAS questionnaire, 46 different items were identified as having to do with law-enforcement technologies. The full list of these questions can be found in the Appendix. Each of these items is a binary variable that asks the agency whether or not they had implemented the said technology as of June 30, 2016. A principal components factor analysis conducted in STATA 17

loaded seven unique factors. While some have criticized the use of factor analyses on dichotomous variables,[53] others have argued that it is acceptable as long as it doesn't result in too many factors.[54] By using tetrachoric correlation matrices to estimate the underlying structure of dichotomous variables, principle components analyses can provide "pseudo-continuity".[55] Furthermore, factor analyses have been used to examine dichotomous variables related to technologies in policing in the literature.

The items that made up these seven factors were then separated so that they were collapsed into individual variables. Each of these scales have strong internal reliability with Cronbach's alpha scores all above 0.6. The first factor (technological outreach) is made up of three questions that ask if the department used their website to give direct access to various statistics or data to citizens. The second factor (social media) is comprised of five items that ask about the various social media platforms the police agency used. The third factor (law enforcement databases) is made up of eight questions that pertain to the various data that is available to police officers while they are in the field. The fourth factor (records management systems; hereafter RMS) consists of 17 items that ask about the various pieces of information the police agency keeps records of. The fifth factor (intelligence collection) consists of seven items that ask about technologies that can be used by the adopting police agency to gather intelligence. The sixth factor (intelligence analysis) is made up of three items that ask about the different ways the police department can analyze the intelligence they have collected. The seventh factor (technological feedback) is comprised of three questions

that ask about whether or not the department uses their website to enable citizens to give them feedback.

Independent Variables

Several variables related to police organization are included in the models to see the degree to which they influence technology adoption. The measures of organizational structure are based on Maguire's (2012) theory of police organizations. Organizational context is measured by police department size (the number of sworn officers), which has been used in prior research. The total budget[1] and the number of calls for service that the agency received are also included; both of these variables are logged. The particular types of crime that a police department frequently responds to also likely influences the types of technology adopted. However, the LEMAS survey only captures the number of calls for service and not what they are for, which is a limitation of the current study. Departments with more officers have higher budgets and are responsible for serving more people, encapsulating the organizational context in which the department operates. Organizational complexity is measured by the primary dimensions of organizational differentiation identified in previous research. Specialization, or functional differentiation,[56] is measured by a scale indicating whether the department has a specialized unit to address 25 different specialized police functions. The specialization index is composed of dichotomous indicators (1= yes) for whether or not a police department has a specialized unit to address various issues such as hate crimes, special operations, gangs, terrorism, and cybercrimes (Cronbach's

[1] Estimated and imputed budget values are not included in the analysis

alpha = 0.9). Occupational differentiation is measured by the percentage of civilian employees (non-sworn officers). Each of these conceptualizations has been used in other research with LEMAS data.[57] An agency's commitment to community-oriented policing is measured by three different variables that describe the agency's relationship with various tactics. SARA, which stands for scanning, analysis, response, and assessment is one of the leading models of a problem-oriented and proactive style of policing. The first variable is the percentage of officers in the department that are actively engaged in SARA-type problem solving projects. The second variable is the percentage of officers in the department that are actively engaged in community-oriented policing strategies. The third variable is a scale that measures the number of active partnerships the police agency had. There were five different questions that asked if the agency had a partnership with a local advocacy group, a business group, another law enforcement agency, a neighborhood association, and a university (Cronbach's Alpha = 0.86). LEMAS has been used to measure community-oriented policing in numerous studies[58],[59] and the operationalization of commitment to COP is consistent with the literature.[60] Professionalization is measured by two variables that have been used in the literature. The first captures the total number of training hours the agency requires each officer to undergo for the job and the second is a binary variable that measures whether or not the department requires at least some college education from prospective applicants.[2]

[2] Other factors could contribute to an officer's professionalism and impact knowledge and skills including specialized training, professional development seminars, and time spent in a particular department.

Analytic Strategy

The analysis began with univariate and bivariate inspections to ascertain the data's nature and suitability for the multivariate tests. Despite the presence of a small number of outliers, they did not influence the results and were therefore included in the final analysis. Correlations between variables ranged from weak to moderate. The strongest correlation was between the number of officers in the department and budget ($r = 0.66$). However, the inclusion of both variables did not alter the substantive multivariate results or reflect multicollinearity, and they are included in the final analysis. Relatedly, multicollinearity is not present in the multivariate analysis, as confirmed by low variance inflation factors (VIFs) that are under 2.15 across the models.[61] As the dependent variables are all counts of different technologies and analyses did not reveal over-dispersion, Poisson-based regression models are employed to perform the multivariate analyses.[62]

Results

Descriptive Statistics

Table 1 shows the descriptive statistics of the seven different technology groupings that make up the dependent variables in the study. As they are all binary variables, the minimums and maximums are shown instead of the standard deviations

in addition to the means. On average, large-city police agencies have more technologies than the other two size categories, with the biggest difference coming with small-city agencies. However, there is relatively little variation on the number of technologies adopted and in general each of the categories of agencies scored relatively high on the various technology scales.

Table 2 shows the descriptive statistics of the police organization variables, including the means and standard deviations. There was more variation between the large-city, medium-city, and small-city agencies on these measures. Large-city agencies on average have much higher operating budgets, more full-time officers, and receive more calls for service. They also tend to be more specialized, require more training hours, and have a higher percentage of civilian employees, than their medium-city and small-city counterparts.

Table 1 about here

Table 2 about here

Multivariate Results

Tables 3, 4, and 5 depict results from the Poisson regression models predicting number of technologies adopted by large-city, medium-city, and small-city police agencies. In lieu of marginal coefficients and to facilitate interpretation, incidence rate ratios (hereafter IRRs) are reported, which are interpreted similarly to odds ratios: a

one-unit change in the selected independent variable corresponds with an increase or decrease in the number of technologies adopted, holding the other independent variables constant. IRRs greater than 1.00 denote positive associations while those less than 1.00 represent negative associations.

Turning to the results for the large-city agencies, very few of the police organizational variables are statistically significant across the seven different models of technology classifications. The percentage of officers engaged in SARA policing tactics is associated with an increase in the number of technologies on the outreach scale (IRR = 1.05, SE = .000, $p \leq .05$), while the size of an agency's budget leads to a modest increase in the number of technologies adopted from the intelligence collection scale (IRR = 1.13, SE = .065, $p \leq .05$). The number of calls for service an agency receives positively predicts the number of technologies adopted on the RMS scale at the $p \leq .10$ level (IRR = 1.05, SE = .03).

The organizational variables are slightly better predictors of technology adoption among medium-city agencies. The percentage of civilians employed by the agency (IRR = 1.01, SE = .007, $p \leq .10$) and the number of problem-solving partnerships the agency is engaged in (IRR = 1.07, SE = .042, $p \leq .10$) have small associations with adoption of technologies on the outreach scale, while the percentage of officers engaged in SARA tactics (IRR = 1.05, SE = .002, $p \leq .05$) positively predicts adoption of these technologies. The number of problem-solving partnerships (IRR = 1.06, SE = .02, $p \leq .01$), positively predicts the adoption of social media platforms, while the budget (IRR = 1.22, SE = .146, $p \leq .10$), is slightly associated with an increase of

technologies on the intelligence collection scale. The number of specialized units (IRR = 1.03, SE = .02) results in an increase in the adoption of technologies in the law enforcement databases scale at $p \leq .10$.

Table 3 about here

Table 4 about here

Table 5 about here

Specialization (IRR = 1.02, SE = .013, $p \leq .10$) and the number of sworn officers (IRR = 1.01, SE = .004, $p \leq .10$) are slightly associated with the adoption of RMS technologies. Budget (IRR = 1.29, SE = .198, $p \leq .10$) and number of problem solving partnerships (IRR = 1.06, SE = .029, $p \leq .05$) are both associated with adoption of technologies on the feedback scale, with budget having a smaller association at $p \leq .10$.

The police organization variables predicted technology adoption among small-city police departments the best of the three categories used in this study. Number of specialized units (IRR = 1.08, SE = .03, $p \leq .01$) and the percentage of officers engaged in community-oriented policing tactics (IRR = 1.04, SE = .444, $p \leq .01$) are associated with an increase in technologies on the outreach scale. The number of problem solving partnerships (IRR = 1.05, SE = .023, $p \leq .01$) positively predicts the adoption of social media platforms. Budget (IRR = 1.48, SE = .118, $p \leq .01$) and percentage of officers engaged in community-oriented policing (IRR = 1.41, SE = .175, $p \leq .01$) are positively associated with adoption of technologies on the intelligence collection scale, while the percentage of civilian employees (IRR = 0.99, SE = .003, $p \leq .01$) is negatively associated. Budget (IRR = 1.22, SE = .061, $p \leq .01$), college requirement (IRR = 1.07, SE = .047, $p \leq .10$), and number of problem solving partnerships (IRR = 1.03, SE = .013, $p \leq .05$) are all positively associated with adoption of technologies on the law enforcement databases scale, with educational requirement significant at $p \leq .10$; number of sworn officers (IRR = 0.99, SE = .000, $p \leq .05$) is negatively associated. The number of specialized units (IRR = 1.02, SE =

.007, $p \leq .05$) and percentage of officers engaged in community-oriented policing (IRR = 1.10, SE = .058, $p \leq .10$) are both associated with an increase in the number of RMS technologies; community-oriented policing is less significant at $p \leq .10$.

Discussion

The current study examined the organizational correlates of technology adoption among municipal police departments in the United States. Several noteworthy findings were revealed from the 21 different Poisson regression models that were conducted. First, technology adoption among American police departments is generally widespread as of 2016. Each of the three subsets of agencies examined, scored relatively high on every technology scale. This supports the work of Ridgeway (2018) and Hollywood and colleagues,[63] who found that both technology adoption and usage has grown rapidly in modern law enforcement. However, there are important differences that were observed between the different subsets of agencies and the different kinds of technology scales, echoing prior works of scholars that have emphasized that innovations and police organizations differ from each other in important ways.

Very few of the organizational variables mattered in predicting technology adoption among the large-city agencies; this makes sense because these agencies have so much more of the resources that are theorized to be of importance such as money and manpower, as well as the demands that come with being in major metropolitan areas, than the other agencies in the sample. Large-city agencies also tend to be more specialized and have more partnerships with other organizations, which necessitates the

adoption of technologies as well. For example, an agency will not use technology to collect data on files related to immigration or special victims if they don't have an immigration or a special victim's unit; they will not use technology to perform analyses on the impact that a recent string of robberies has had on local businesses if they don't have a partnership with community business groups. This also supports the innovations literature, which proposes that larger organizations are better equipped to implement innovations.[64] However, organizational characteristics do make a difference in technology deployment among medium-city and small-city agencies. Among medium-city agencies, the size of their operating budgets and the number of problem solving partnerships that they have forged are associated with important variations in the degree to which an agency adopts technologies. In particular, a one-unit increase in budget makes a large difference in whether or not medium-city agencies adopt intelligence collection (22% increase) and feedback (29% increase) technologies. It should be noted that the budget was logged so a one-unit increase represents tens of thousands of dollars. However, the finding is still significant because the size of budget doesn't play a role in whether or not medium-city agencies adopt the other types of technologies included in the study. This is even more important for small-city agencies: a one-unit increase in budget results in a large increase in the degree to which agencies adopt intelligence collection (48% increase) and law enforcement database (22% increase) technologies. The percentage of officers in the department that are engaged in community-oriented policing tactics is also predictive of whether or not small-city

agencies adopt intelligence collection (41% increase) and RMS (10% increase) technologies.

This last finding is especially interesting as community-oriented policing was not a correlate of technology adoption for medium-city or large-city agencies. This could be explained by a number of factors. It could be that implementation of and commitment to COP varies significantly or that the goals of COP are more easily achieved in smaller communities, where police officers are more likely to form relationships with their constituents. The degree to which a police agency is committed to community-oriented policing, which encourages more proactive and problem-solving strategies, impacting technology deployment, could also be seen as support for the work of Lum and colleagues (2017). It appears that in small-city agencies, that don't have the same amount of resources as larger departments, organizational culture can make a big difference in whether or not an agency adopts technologies. These departments are more engaged with the communities they serve, more aware of the issues affecting them, and are more likely to adopt different technology innovations in an attempt to solve them. The fact that community-oriented policing only matters for small-city agencies ties into one of the more important findings of the study, which is that there is a gap in the services provided between large-city and small-city policing in America. Organizational factors are not significant for the bigger departments because they already have all of the resources they need to adopt whatever kind of technology they want. However, the small-city departments have to make choices on which technologies to adopt with their limited budgets. The 10 million people that are serviced by these

agencies are essentially dependent upon the organizational culture and programs of their local agency to determine whether or not they will be technologically innovative. There are also over 1,100 agencies operating in the United States that serve populations of less than 10,000 people that can be assumed to be even more dependent upon organizational characteristics for the degree to which they are technologically innovative. While it can be argued that these smaller departments don't have as much of a need for such advanced technologies, the findings of the present study indicate that smaller-city agencies still wish to have these technologies as they adopted them when they had the budgets to do so. Furthermore, the number of calls for service a department received was not a significant correlate for any of the technologies so demand doesn't seem to be a factor driving technology adoption, as some research has found.[65]

This brings attention to the last key finding of the study, which is that technologies differ from each other in their ease of adoption. This is most clearly seen in the intelligence collection scale. While the other technology scales were generally adopted to a large degree across all three types of agencies, these technologies varied considerably among the medium-city and small-city agencies. Several organizational characteristics, such as the budget, number of problem solving partnerships, and community-oriented policing commitment correlated with the adoption of these technologies. They are more complicated to implement than other technologies and are used by the police for multiple purposes and often in ways that differ substantially from traditional policing methods, including stopping crimes before they occur, responding to

the concerns of citizens, and relying upon information technology and intelligence to inform strategy and tactics. They also require internal support and operation by the police agencies themselves. These innovations are more difficult for police agencies to successfully implement because they are more technically complex and require a greater level of training and education from the officers using them, which is costly and time-consuming. They need to be internally managed and maintained, which is expensive for smaller budget-strapped police departments, and the complicated nature of these systems means that they will not work without a high degree of commitment and integration into existing organizational practices and procedures, which has been demonstrated in other sectors.[66],[67]

Limitations

As with all studies, the current analysis has its limitations. First, the data used in the present analysis comes from 2016 and both the availability and ease for adoption of technologies has changed a lot over the past eight years. As such, some of the findings may not be generalizable to police agencies today since they likely have adopted more technologies since 2016. However, the findings related to the types of technologies and their varying difficulty of adoption might still be relevant today since there will always be new technologies that come out and will present challenges to initially implement. Given the correlational nature of the study this paper is unable to make causal claims regarding efficiency and effectiveness. Although associations between organizational structure and technology adoption are found, this analysis is unable to ascertain the mechanism linking these two factors. For example, the mechanisms could constitute

frequency of use of adopted technologies, familiarity of employees with the adopted technologies, and interactions between multiple technologies adopted together. As the literature suggests, police agencies can implement technologies but use them in sub-optimal ways. Furthermore, the LEMAS survey does not ask the number of individual technologies that each department has implemented, only if they have one of them. If a large-city agency like the New York Police Department (NYPD) or Los Angeles Police Department (LAPD), for example, only has one gunshot detection system or NIBIN kit, they will not be able to effectively service the large community they serve with these technologies. Future research should seek to develop more effective ways to measure how police agencies use the technologies they have implemented. Another limitation that analyses of technology adoption must contend with is reverse causality. While the literature and this paper both propose that organizational structure influences the technologies a police department adopts, the opposite could be true in some situations. For example, a department could change its policies or create a new unit in its structure as a result of acquiring gunshot detection systems or license plate readers. Future data collections should facilitate studies that examine the relationship between police organizational factors and technology adoption quantitatively.

Conclusion

Technology has long been sought to improve police effectiveness and efficiency and represents one of the largest expenditures that police departments make each year. This study has demonstrated how organizational variables influence police adoption of various technologies, as well as identified the importance of studying

different kinds of police organizations (namely those that serve cities of less than 100,000 people) and of different kinds of technologies. As police practitioners continue to implement different types of technological innovations it is vital that they recognize how characteristics of a particular technology can impact whether or not it is successfully adopted by their organization. This includes a technology's function, if it requires line officers to change their role, and how much information sharing is necessary for the technology to be used effectively. This research also discovered ways that smaller police agencies are able to adopt technologies, revealing the importance of organizational culture. While the budget they have to work with and the number of officers they employ may be outside of the control of police chiefs and practitioners, inculcating culture that encourages the use of technology to proactively prevent crimes and effectively creating more specialized units is not. As policing moves through the 2020s, the ability of the police to adequately implement and utilize the technologies that are available to them is of the utmost importance. These technologies, when used effectively, can have important social benefits like lowering crime and improving police-community relations. The findings of this study suggest that police agencies can be altered and organized in fashions that may increase the number of technologies that they deploy.

Table 1. Descriptive Statistics for Dependent Variables

DEPENDENT VARIABLES *Police Technologies*	*Large City Agencies* *(n = 269)* *Mean* *(Min/Max)*	*Medium City Agencies* *(n = 242)* *Mean* *(Min/Max)*	*Small City Agencies* *(n = 440)* *Mean* *(Min/Max)*
Outreach	1.57 (0/3)	1.16 (0/3)	0.80 (0/3)
Social Media	3.31 (0/5)	2.70 (0/5)	2.10 (0/5)
Intelligence Collection	4.69 (1/7)	3.66 (0/7)	2.40 (0/7)
Databases	7.14 (0/8)	6.76 (0/8)	6.02 (0/8)
RMS	14.89 (2/17)	14.05 (2/17)	12.58 (0/17)
Feedback	2.46 (0/3)	2.17 (0/3)	1.76 (0/3)
Intelligence Analysis	2.84 (1/3)	2.63 (0/3)	2.19 (0/3)

Table 2. Descriptive Statistics for Independent Variables

INDEPENDENT VARIABLES *Police Organization*	*Large City Agencies* *(n = 269)* *Mean* *(SD)*	*Medium City Agencies* *(n = 242)* *Mean* *(SD)*	*Small City Agencies* *(n = 440)* *Mean* *(SD)*
Organizational Context			
Budget (ln)	18.0 (0.92)	16.79 (0.40)	15.46 (0.69)
# of Officers	779.27 (2,415.9)	139.48 (48.93)	48.27 (35.06)
Calls for Service (ln)	12.26 (0.94)	11.19 (0.68)	10.05 (0.81)
Organizational Complexity			
Civilianization	23.49 (8.56)	21.5 (9.42)	18.0 (9.26)
Specialization	12.38 (1.10)	11.86 (1.56)	10.86 (2.19)
Professionalization			
Educational Requirement	0.27 (0.44)	0.28 (0.45)	0.26 (0.43)
Training Hours	1,523.7 (407.4)	1,338.7 (428.7)	1,035.9 (539.7)
Community Oriented Policing			
# of Partnerships	3.57 (1.66)	3.21 (1.65)	2.28 (1.70)
Problem Oriented Policing	25.46 (23.2)	24.65 (24.71)	19.9 (26.8)
Community Policing Commitment	36.77 (15.3)	35.86 (18.7)	30.5 (27.6)

Table 3. Poisson Regression Results for Large City Agencies (*n* = 269)

Large City Agencies (n = 269) *VARIABLES*	*Outreach* *IRR (SE)*	*Social Media*	*Intelligence Collection*	*Databases*	*RMS*	*Feedback*	*Intelligence Analysis*
Organizational Context							
Budget (ln)	.9797	1.034	1.130*	1.005	.9759	.9937	.9980
	(.0975)	(.071)	(.0654)	(.0476)	(.031)	(.8060)	(.074)
# of Officers	.99999	.99999	.999995	1.000	.9999	.9999	.9999
	(.0002)	(.001)	(.0002)	(.0001)	(.001)	(.0002)	(.001)
Calls for Service (ln)	1.0689	1.069	.9938	.9760	1.05+	1.006	1.022
	(.0973)	(.067)	(.0529)	(.0419)	(.031)	(.0735)	(.069)
Organizational Complexity							
Civilianization	1.0053	1.0026	1.0040	1.004	1.002	1.003	1.001
	(.0059)	(.004)	(.0035)	(.0028)	(.0019)	(.0048)	(.004)
Specialization	1.053	1.0187	1.045	1.010	1.022	.9971	.9981
	(.0581)	(.035)	(.0320)	(.0223)	(.016)	(.0365)	(.033)
Professionalization							
Educational Requirement	1.0993	1.044	.9523	1.028	1.010	1.029	1.013
	(.1191)	(.078)	(.0617)	(.0528)	(.0363	(.0902)	(.083)
Training Hours	.9998	1.001	1.001	1.001	.9999	.9999	.9999
	(.0001)	(.008)	(.0007)	(.0006)	(.001)	(.0001)	(.001)
Community Oriented Policing							
# of Partnerships	1.049	1.024	1.018	1.005	1.011	1.023	.9999
	(.0332)	(.022)	(.0184)	(.0145)	(.0101	(.0255)	(.022)
Problem Oriented Policing	1.005*	1.001	1.001	1.001	1.001	1.002	1.001
	(.0022)	(.001)	(.0013)	(.0010)	(.0007	(.0018)	(.001)
Community Policing Commitment	.6521	1.172	1.040	1.157	1.100	.9075	1.123
	(.2257)	(.289)	(.2142)	(.1958)	(.129)	(.2575)	(.299)

Note: ***p ≤ .001 **p ≤ .01 *p ≤ .05 +p ≤ .10 (two-tailed tests).

IRR = incidence rate ratio. SE = standard error.

Table 4. Poisson Regression Results for Medium City Agencies (*n* = 242)

Medium City Agencies (n = 242) *VARIABLES*	*Outreach* *IRR (SE)*	*Social Media*	*Intelligence Collection*	*Databases*	*RMS*	*Feedback*	*Intelligence Analysis*
Organizational Context							
Budget (ln)	1.096	1.145	1.229+	1.047	.9079	1.297+	.9562
	(.244)	(.158)	(.146)	(.091)	(.055)	(.198)	(.133)
# of Officers	1.001	.9999	1.001	.9998	1.001+	.9988	1.001
	(.001)	(.001)	(.001)	(.007)	(.004)	(.001)	(.001)
Calls for Service (ln)	.9723	1.016	1.001	1.009	1.010	.9275	.9768
	(.090)	(.0631)	(.052)	(.039)	(.027)	(.063)	(.060)
Organizational Complexity							
Civilianization	1.012+	.9999	1.001	1.001	1.002	1.005	1.004
	(.007)	(.004)	(.003)	(.002)	(.002)	(.005)	(.004)
Specialization	1.033	1.008	.9819	1.032+	1.023+	1.007	1.030
	(.051)	(.030)	(.024)	(.020)	(.013)	(.033)	(.032)
Professionalization							
Educational Requirement	.9127	.9497	.9048	1.068	.9675	.9464	1.019
	(.133)	(.088)	(.073)	(.061)	(.039)	(.098)	(.095)
Training Hours	.9997	1.001	1.001	1.001	.9999	.9999	1.001
	(.001)	(.0009)	(.0007)	(.0005)	(.0004)	(.001)	(.0009)
Community Oriented Policing							
# of Partnerships	1.074+	1.060**	1.006	1.018	.9974	1.061*	1.015
	(.042)	(.026)	(.0211)	(.015)	(.010)	(.029)	(.025)
Problem Oriented Policing	1.005*	1.001	1.001	.9994	1.000	.9992	1.001
	(.002)	(.0017)	(.001)	(.001)	(.0007)	(.001)	(.0017)
Community Policing Commitment	1.765	1.222	1.071	1.149	1.063	1.209	1.019
	(.671)	(.293)	(.219)	(.173)	(.110)	(.327)	(.244)

Note: ***p ≤ .001 **p ≤ .01 *p ≤ .05 +p ≤ .10 (two-tailed tests).

IRR = incidence rate ratio. SE = standard error.

Table 5. Poisson Regression Results for Small City Agencies (*n* = 440)

Small City Agencies (n = 440) *VARIABLES*	*Outreach* *IRR (SE)*	*Social Media*	*Intelligence Collection*	*Databases*	*RMS*	*Feedback*	*Intelligence Analysis*
Organizational Context							
Budget (ln)	1.189	1.137	1.484**	1.221**	1.038	1.061	1.064
	(.162)	(.095)	(.118)	(.061)	(.035)	(.096)	(.086)
# of Officers	.9996	.9993	1.001	.9971*	1.001	.9976	1.001
	(.002)	(.001)	(.001)	(.001)	(.0007)	(.002)	(.001)
Calls for Service (ln)	.9719	1.020	.9992	.9988	.9988	1.061	1.034
	(.089)	(.057)	(.052)	(.033)	(.022)	(.064)	(.056)
Organizational Complexity							
Civilianization	1.009	.9997	.9927**	.9973	1.001	.9978	1.001
	(.006)	(.003)	(.003)	(.002)	(.001)	(.004)	(.003)
Specialization	1.085**	1.027	1.005	1.005	1.024*	1.030	1.024
	(.033)	(.018)	(.016)	(.010)	(.007)	(.019)	(.017)
Professionalization							
Educational Requirement	.8181	1.054	.9378	1.079+	.9834	1.075	1.038
	(.105)	(.079)	(.068)	(.047)	(.031)	(.088)	(.077)
Training Hours	.9999	1.001	1.001	1.001	1.001	.9999	1.001
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.0005)
Community Oriented Policing							
# of Partnerships	1.033	1.058**	1.015	1.030*	1.003	1.090**	1.033
	(.036)	(.023)	(.020)	(.013)	(.008)	(.025)	(.021)
Problem Oriented Policing	.9994	.9998	1.001	1.001	1.001	1.001	1.001
	(.001)	(.001)	(.001)	(.0007)	(.0005)	(.001)	(.0012)
Community Policing Commitment	1.048**	1.097	1.415**	1.045	1.106+	1.101	1.101
	(.444)	(.142)	(.175)	(.079)	(.058)	(.155)	(.139)

Note: ***p ≤ .001 **p ≤ .01 *p ≤ .05 +p ≤ .10 (two-tailed tests).

IRR = incidence rate ratio. SE = standard error

Appendix

These are the questions that make up the various technology scales used in the paper as they appear in the 2016 LEMAS survey.

Social Media Scale

As of June 30, 2016, did your agency use any of the following social media channels to communicate with the public?

a. Twitter
b. Facebook, Google+, or similar service

c. Blogs

d. YouTube or other video sharing service

e. Mass communication/notification system (e.g., Nixle)

Law Enforcement Databases Scale

As of June 30, 2016, did your agency's field/patrol officers have direct access to the following types of information using in-field vehicle-mounted or mobile computers

a. Motor vehicle records

b. Driving records
c. Criminal history records

d. Warrants

e. Protection orders

f. Inter-agency information system

g. Address history (e.g., repeat calls for service)

h. Crime statistics/mapping

RMS Scale

As of June 30, 2016, did your agency maintain its own computerized files with any of the

following information?

a. Arrests

b. Calls for service

c. Civilian complaints

d. Criminal incident reports

e. Firearms recovered, seized or found

f. Gangs

g. Informants

h. Intelligence related to terrorist activity

i. Motor vehicle stops

j. Motor vehicle accidents

k. Pawn shop data

l. Protective orders

m. Stolen property

n. Street/field stops

o. Use of force incidents

p. Video surveillance

q. Warrants

Feedback Scale

As of June 30, 2016, did your agency maintain a website for any of the following?

a. Enabling citizens to report crimes or problems

b. Enabling citizens to ask questions and/or provide feedback

c. Enabling citizens to file complaints about police behaviors or actions

Intelligence Collection Scale

As of June 30, 2016, did your agency use any of the following technologies on a REGULAR basis?

a. Automated Fingerprint Identification System (AFIS)

b. License plate readers (LPR)

c. Infrared (thermal) imagers

d. Gunshot detection (e.g., ShotSpotter)

e. Firearm tracing (e.g., eTrace)

f. Ballistic imaging (e.g., NIBIN, IBIS)

g. Global Positioning System (GPS)

Intelligence Analysis Scale

As of June 30, 2016, did your agency use computers for any of the following functions?

a. Crime analysis (including crime mapping or hotspot identification)

b. Social network analysis

c. Intelligence gathering

Outreach Scale

As of June 30, 2016, did your agency maintain a website for any of the following?

a. Providing direct access to crime statistics/data

b. Providing direct access to stop (i.e., motor vehicle or street/field) statistics/data

Providing direct access to arrest statistics/data

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