ABSTRACT

Thesis Title:	THE FAILURE TO INNOVATE: A STUDY OF NON ADOPTION OF COMPUTERIZED CRIME MAPPING IN AMERICAN POLICE
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Scholars have noted a recent accumulation of innovations in policing (Bayley, 1994; Weisburd & Braga, 2006; Weisburd & Eck, 2004). Due to the increase and scope of these innovations, some scholars have called this the most dramatic period of innovation in policing (Bayley, 1994). Studies have tried to explain why this dramatic period of innovation occurred, but while in general the study of the diffusion of innovations is widespread (Rogers, 2003), there have been relatively few in policing (Klinger, 2003; Weisburd & Braga, 2008). Particularly, little is known about the relationship between resources and innovation. The current work attempts to better explain this relationship by increasing the scope of resources measured and by disentangling the effects of measures employed in the extant literature. In contrast to previous studies (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005; Weisburd et al., 2003), findings from the current work indicate that various measures of resources are not related to innovation and those who fail to innovate.

THE FAILURE TO INNOVATE: A STUDY OF NON ADOPTION OF
COMPUTERIZED CRIME MAPPING IN AMERICAN POLICE

by

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CHAPTER I: Introduction

Scholars have noted a recent accumulation of innovations in policing (Bayley, 1994; Weisburd & Braga, 2006; Weisburd & Eck, 2004). These innovations have begun to rely on multiple approaches and various levels of focus beyond the traditional scope of uniformity, reactionary, and strictly law enforcement techniques (Weisburd & Eck, 2004). Additionally, these changes are not just strategic approaches such as community policing and problem oriented policing, but also encompass a slew of new technological and scientific changes including computerized crime mapping and DNA sequencing. Because of this accumulation and scope some scholars have called this the most dramatic period of innovation in policing (Bayley, 1994).

David Weisburd and Anthony Braga (2006) have recently argued that this period of dramatic innovation did not occur by coincidence. Starting in the late 1960's, several stimuli emerged which challenged the role of the police. Empirical studies questioned their effectiveness (see Kelling et al., 1974; Spelman & Brown, 1984), crime rates were rising dramatically, and issues of police legitimacy all placed stressors on the field (Weisburd & Braga, 2006). In a sense, innovation was a reaction to these stressors. Innovation aimed to increase legitimacy while simultaneously making the police relevant again, even if that meant dramatic changes to their strategies and goals.

Innovation was an important reaction to the stress placed on police, but beyond these stimuli discussed by Weisburd and Braga (2006), some scholars have tried to expand on why this dramatic period of innovation occurred (Chamard, 2004;

King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005; Weisburd et al., 2003; Weisburd & Lum, 2005; Weiss, 1997). While in general the study of the diffusion of innovations is widespread[1], there have been relatively few which examine this dramatic period of innovation in policing (Klinger, 2003). A recent search of the National Criminal Justice Reference Service and Criminal Justice Abstracts by Weisburd and Braga (2008) was only able to identify eight such studies out of the over 190,000 abstracts.

One piece of this puzzle is explaining the role of resources. Was this dramatic period of innovation also influenced by resources? Did the lack of resources prohibit departments from innovating? If so, which specific resources were influential? However, this relationship has also received little attention within the policing literature. In policing, there is generally a positive link between resources and innovation—the more resources a department has the more likely they are to innovate and conversely the less resources a department has the less likely innovation becomes (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005; Weisburd et al., 2003). Department size (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005), outside funding (Mastrofski et al., 2003), and human capital (Skogan & Hartnett, 2005) are some measures of resources which have been related to innovation.

However, there are several critiques of this literature which the current work attempts to address. These various critiques largely stem from the failure to completely measure the myriad of variables that can be considered a resource. And

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[1] From one recent estimate there have been over 5,200 published studies on the diffusion of innovation with an additional 120 being added each year (Rogers, 2003).

these critiques reveal potential problems in the extant literature which can influence research findings with regards to resources. Therefore, the current work tries to expand and improve on the prior literature by more completely measuring resources which will hopefully increase our understanding of its relationship with innovation.

The first critique begins with the scope of resources used in the current policing literature—studies do not use the full range of variables which can be considered a resource (Wejnert, 2002). For example, Skogan and Hartnett (2005) exclude budget, Chamard (2004) excludes human capital, and Mastrofski et al. (2003) exclude budget, human capital, and community size. Without including the wide array of resource measures in a model it is difficult to draw any conclusions from the literature as to the relationship between specific resources and innovation.

The inability to discern this link becomes evident from the following critiques, which stem from this incomplete measure of resources. Without controlling for the wide array of resource measures a study may falsely conclude a relationship exists due to a spurious relationship (Mohr, 1969).

Figure 1: Spurious Relationship
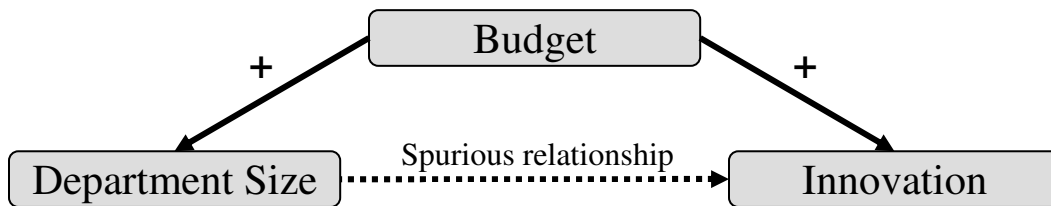
The above theoretical example demonstrates the concern over the findings of a study that omits a variable correlated with both the independent and dependent variable. If department size is included in the theoretical model while omitting budget, then the

study might falsely conclude that department size is related to innovation, when in fact it is the omitted resource variable, budget, which drives the relationship. Thus, the relationship between department size and innovation is *indirect.* This concern is validated when one considers that studies frequently include only one or two measures of resources as discussed above. And these measures are most likely correlated with one another (Chamard, 2004; Rogers, 2003). This correlation and omission create an environment where spuriousness could occur.

Even if a larger host of resources is included to avoid problems of spuriousness, high correlation among these measures leads to concerns of multicollinearity (Bachman & Paternoster, 2004). This correlation of resources noted by Chamard (2004) and Rogers (2003) stems from the idea that many of the measures employed to capture resources are part of a larger underlying or latent construct, a notion that previous studies have overlooked. Thus, it is not appropriate to include these variables in a model without addressing their inter-correlation.

Figure 2: Multicollinearity
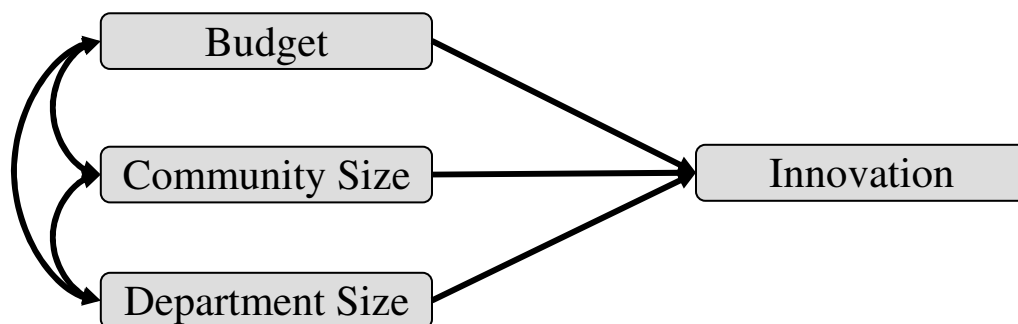
When the above relationship occurs, the estimation of the effect of the independent variables is biased because some of its influence is either masked or

enhanced by correlated variables. Multicollinearity leads to large standard errors and the increased risk of a type II error—failing to reject a null hypothesis that is actually false (Pindyck & Rubinfeld, 1998). This makes it more difficult to find relationships if they actually exist. Thus, if a study does not include the proper measures of resources they could run the risk of spuriousness, but if they include too many highly correlated measures they could run the risk of multicollinearity. However, if these problems are recognized they can be adequately addressed.

The idea that certain measures of resources are correlated and perhaps part of a larger construct has been previously discussed (Chamard, 2004; Rogers, 2003), but it has not statistically been explored. The existence and discussion of highly correlated resource measures is only one step, but a factor analysis would determine if there is a singular underlying construct, which would indicate that the various measures could be summarized in a single measure, in a parsimonious manner (Hair et al., 1992). This is particularly useful when considering the myriad of variables potentially representing resources (Wejnert, 2002).

Finally, current studies in policing fail to assess the relationship between resources and those who *fail* to innovate (see Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003; Weisburd & Lum, 2005; Weiss, 1997). While the extant literature has been preoccupied with studying those who adopt, it is less clear what influences those police agencies who fail to adopt. Are these organizations financially unable to innovate? Why would a department fail to innovate if there was empirical support for its usage, if it was readily available, and if the majority of their peers had adopted it? In this sense these agencies are at least

unique if not organizationally challenged. The general organizational literature is also largely preoccupied with studying who innovates, but there is some theory as to why people fail to innovate. However, it usually assumes that individuals and organizations innovate and fail to innovate for similar reasons (Rogers, 2003).

To better explore the relationship between resources and the failure to innovate, the current work will attempt to address each of these critiques. To examine this, the study will use the adoption of computerized crime mapping as an instance of innovation.

Computerized Crime Mapping

Computerized crime mapping is largely used to facilitate hot spots analysis (Weisburd & Lum, 2005), which has both theoretical (Cohen & Felson, 1979) and empirical (Sherman & Weisburd, 1995) support. Because of this evidence base for hot sports analysis, computerized crime mapping adoption is viewed as offering what Rogers' would call, a relative advantage (2003). In this case, it provides an improved method for dealing with crime and disorder, which all larger municipal departments should adopt. Computerized crime mapping was chosen for this study because of this relative advantage, theoretical and empirical support. The following section will help orient the reader as to the origins of computerized crime mapping and its utility in policing as an innovation.

While maps are probably as old as humankind, mapping of social phenomenon did not occur until more recently (Bagrow & Skelton, 1985). The first crime map was produced jointly by French lawyer and statistician André-Michel

Guerry and the Venetian geographer Adriano Balbi. In their 1829 work *Statistique Comparée de l'état de l'Instruction et du Nombre des Crimes*, these authors produced three shaded crime maps of France based on data from the *Compte Général* and the French census (Friendly, 2007). Importantly, the maps allowed individuals to see spatial relationships between variables. The authors reported on various measures, including rates of crime against the person, crimes against property, and illiteracy rates in the various French Départments, finding that the areas with the highest levels of education also had the highest rates of property crimes among all French Départments. In further work with mapping, Guerry included tables with numeric data to create maps. He recognized the advantages of mapping crime early on, noting that trends could be lost by simply looking at lists of frequency tables and figures, while graphing this information can help reveal them. Even though aggregate crime counts were fairly stable from year to year, using thematic maps the French lawyer was able to easily convey the considerable variation between the French Départments across the type and quantity of crime (Beirne, 1993).

However, these early advances in mapping which provided a unique interpretation of crime, and revealed various ecological trends, soon faded away from the study of crime. Positivist criminology came to dominate theory and the idea of locating geographic variations and correlations through mapping dissipated. But a combination of factors came together fortuitously which helped lead to its recent resurgence (Weisburd & McEwen, 1997). First, theoretically, the geography of crime became highly important. While prior theories of crime were largely concerned with explaining why individuals committed crime (see Akers, 1973; Gottfredson &

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Hirschi, 1990; Hirschi, 1969; Sheldon, 1954) including juveniles (Cohen, 1955), women (Adler, 1975; Simon, 1975), and across the life course (Sampson & Laub, 1993), a shift in these ideas towards criminal places (see Cohen & Felson, 1979) began to emerge after sharp criticism of these earlier theories. Scholars began to study the context in which crime occurred instead of focusing on individual motivations (Weisburd & Braga, 2006), and crime mapping became an important tool in these analyses. Additionally, crime mapping is particularly useful in hot spots analysis which has gained empirical support for reducing crime (Sherman & Weisburd, 1995).

Coupled with theoretical and empirical support, the cheaper and readily available increases in computing power helped crime mapping go high-tech (Harries, 1999). The creation of early crime maps used to be the result of labor and resource intensive work. Unfortunately, these efforts were only able to produce static maps where patterns and longitudinal trends were difficult to discern. Philip Canter describes this laborious process in Baltimore County Maryland where it took 12 maps covering 70 square feet to display the whole county (Canter, 1997). But with computers, maps can be stored on a hard drive which takes up much less space. In addition, maps were now dynamic, and operators could display longitudinal trends and various crime types without taking up 70 square feet for each map displayed.

One of the earliest uses of *computerized* crime mapping occurred in the mid-1960's in St. Louis (Harries, 1999). Since then computerized crime mapping has diffused rapidly among larger American municipal police departments, particularly as computing power has increased. As of 2003 nearly 70%[2] of these departments had

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[2] This figure is based on my analysis of the 2003 Law Enforcement Management and Administrative Statistics Survey.

adopted computerized crime mapping. While this is an impressive figure, and even though computerized crime mapping has theoretical support, empirical support, is readily available, and has been adopted by a large percentage of potential adopters (Weisburd & Lum, 2005), 34% of larger American municipal police departments have yet to adopt.

Summary

It appears that resources has some relationship to innovation and some role as a hurdle to potential adopters (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005; Weisburd et al., 2003), but the nature of that relationship is currently unclear due to the lack of a comprehensive study exclusively focusing in on resources as a key variable of interest. This study improves on the previous literature by first focusing on those police departments who fail to innovate and second, by using a more vigorous measure of resources. This relationship is just one piece of the puzzle, but one in need of attention if we want to have a larger picture of what influences the diffusion of innovations in policing.

CHAPTER II: Innovation, Resources, and Policing

In the past few decades policing has undergone a period of rapid innovation (Bayley, 1994; Weisburd & Braga, 2006; Weisburd & Eck, 2004). Many scholars have tried to explain why this occurred (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003; Weisburd & Lum, 2005), and there are a few studies which have found some relationship between resources and innovation in policing (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003). In order to avoid confusion and be completely clear about the constructs the above studies examine, a thorough independent discourse on innovation and resources must take place to have an understanding of the following issues: What is innovation? How have previous scholars defined it? How have previous scholars measured it? What are resources? How can they be defined? How can they be measured? There are no straight forward answers to these questions, but there should be some level of familiarity with the issues before an exploration between the two constructs, resources and innovation, can be discussed.

What is Innovation?

Innovation is difficult to define and there will probably never be a universally agreed upon definition. King (2000) has briefly summarized the varying definitions of innovations calling attention to the lack of congruence with respect to policing, which in turn makes it difficult to compare studies. In addition, no clear discernable conclusions can be drawn about the relationship between resources and the failure to

innovate, if it is unclear what innovation is. This thesis will take several approaches to help define innovation relying on multiple methods and sources.

First, using the classic work on the diffusion of innovation by Everett Rogers, we are left with his words in which he noted, "[innovation is] an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (2003, p. 36). Others have also used a similar criterion of being new such as Kimberly and Evanisko who defined innovation as something being state of the art for the field (1981). Based on this seminal work by Rogers (2003), innovation appears to be something new to the field.

Rogers provides one criterion, but what can policing scholars offer? While they are not as direct in defining innovation, analyses of their studies can provide some insight as to what they mean by innovation. This section will review some the current definitions employed, it will explore some of the strengths and weaknesses of each, and finally it will conclude by trying to synthesize these varying definitions into a better measure.

A recently published book provides contrasting perspectives for eight policing innovations, and provides a good starting point in the literature for defining innovation (Weisburd & Braga, 2006). Without specifically mentioning by name, the editors do provide evidence as to what is meant by innovation noting, "In what is a relatively short historical time frame the police began to reconsider their fundamental mission, the nature of the core strategies of policing, and the character of their relationships with the communities that they serve" (Weisburd & Braga, 2006, p. 1). Similar to Rogers, innovation appears to mean something new, but one which

changes the way police departments previously operated. In this case their mission, strategies, and relationship with the community, changed.

A similar definitional extraction can be made in another recent diffusion of innovation work (Weisburd & Lum, 2005).

> "In recent years, computerized crime mapping has become a central focus of practitioners and scholars concerned with crime analysis and the geographic distribution of crime. However, while it is clear that computerized crime mapping has emerged as an important focus of innovation in policing, there has been little scholarly review of the development of computerized crime mapping as an innovation and the factors that have influenced its adoption in American police agencies" (p. 419).

Computerized crime mapping is specifically identified as an innovation. The author's note that in relatively recent times it has become important and that it changes the way the police operate. In this instance, police now use maps to analyze crime. Again, certain components of innovation appear: a level of newness and development of new approaches.

Some studies are less direct. Skogan and Hartnett (2005) note that, "This study treats adoption and utilization of the Data Warehouse by other police departments as an instance of the diffusion of innovation" (p. 402). The innovation they are talking about was free access to a database based in Chicago. Specifically, this innovation was a technology which was not necessarily new, but new to those who adopted it. It appears that the authors are interpreting Rogers' perceived to be new reference. While crime databases are not new, this particular one was perceived to be new. Because of this, use of the data warehouse was considered an innovation.

Weiss' 1997 study is more nuanced. Innovativeness has two components, subjective and objective. The objective component measures the number of innovations that the organization has adopted and the subjective measures how members of the organization feel about the reputation of their organization with respect to innovativeness. He lists the seven innovations which were used to create a scale, but gives no direct definition of innovation. However, the author does footnote the innovations, explaining their inclusion based on their attention they were recently receiving in the police community.

A synthesis of these definitions would lead us to conclude that innovation is something perceived as being new, which changes police practices, and which has received attention in the policing community. But maybe trying to define innovation is not the best approach to identifying them. As just discussed, Weiss' (1997) scale has two measures of innovation. The second component asks about the reputation of the organization as an innovator. This avoids problems of constructing a definitional criterion, but this is not very useful in trying to identify specific innovations.

Perhaps a better way is to try and list several innovations and then try to recognize similar components of them. To quote Supreme Court Justice Potter Stewart, maybe we can "know it when we see it" with regards to innovation. Moore, Spelman, and Young (1992) take on a similar task, but instead of relying on one method to identify innovation, they use three: a survey of practitioners in policing, a survey of policing experts, and a content analysis of journals and conferences in the field. The authors summarize and use these three methods in order to ascertain a list of current innovations in policing as well as determine which method is best for

obtaining further lists. In addition to identifying policing innovations the authors sought to rank them in order of importance.

While their study provides a list of innovations, what it more importantly demonstrates is a more rigorous methodology for identifying them beyond a simple definitional approach. Triangulating the results from their three methods will probably provide a clearer picture of what innovation is over relying on a singular method. However, this does not necessarily help the current work. The Moore et al., (1992) piece is sixteen years old and any list of innovations they compiled will probably be reflective of policing innovations in 1992 and not 2008. Therefore, the current work will rely on their multiple methods approach to demonstrate how the current works innovation, computerized crime mapping, fits this categorization.

In the end, this documents main goal is not to define innovation, but it is necessary to demonstrate how computerized mapping fits into the realm of studies on the topic. When this is done, the results can perhaps be applied to the field of innovation more globally or at least within policing.

Computerized Crime Mapping

The prior section provided a discussion on the various definitions and methods used to define innovation, and the best approach among these is triangulation. Building off the multiple methods approach of Moore et al., (1992), this thesis uses several sign posts which demonstrate evidence in support of calling computerized crime mapping an innovation. The first step taken was to see what policing experts or scholars said about the issue. They have in fact previously called

computerized crime mapping an innovation (Chamard, 2004; Harries, 1999; Weisburd & Lum, 2005) offering one sign post.

Aside from being called an innovation, computerized crime mapping also fits the criterion of being new as discussed by Rogers (2003) and Kimberly and Evanisko (1981). Looking through the various years of Law Enforcement Management and Administrative Statistics Surveys, the reports only started asking about computerized crime mapping in 1997. Also, Keith Harries (1999) traces the history of crime mapping in his book for the Crime Mapping Research Center, and in doing so provides an estimation for the "newness" of computerized crime mapping. While comparing computing power between 1984 and 1999 the author concludes that 1999 had, "the type of computing environment that would facilitate the entry of GIS into law enforcement (and elsewhere) and permit cartographic principles and practices to be used on a day-to-day basis. Mapping crime has come into its own primarily because of advances in computing that, in turn, have facilitated GIS applications" (Harries, 1999, p. 6). This suggests that computers have only recently gained the power to properly map crime.

Finally, computerized crime mapping changes police practices. Crimes can now be mapped, trends can be visualized, and hot spots can more easily be identified. In other words, the police can more focus on crime places and the context of crime at the micro level as opposed to more macro levels.

Computerized crime mapping has previously been called an innovation, is relatively new, and changes the way police operate. Taking these three pieces of evidence together provides the basis for classifying computerized crime mapping as

an innovation. Regardless of this evidence, by studying those who fail to innovate, the task of selecting something "new" and "state of the art" is a bit easier. There are definitional issues with gauging what is new, but by looking at those who fail to innovate it becomes almost unnecessary to define. Enough time must pass for the innovation to be adopted by a non trivial amount of departments in order to separate out adopters from non adopters. Studying an innovation during its nascent in policing might not provide meaningful numbers of departments in these two categories. In other words, something too state of the art might not have the requisite heterogeneity to supply enough statistical power to detect a difference between the groups, when one actually exists. Therefore, it is probably not advantageous to heavily rely on the newness criterion when an innovation is dichotomously operationalized.

Measuring Innovation

If defining innovation was not challenging enough, it is also difficult to operationalize. Even if there was an agreed upon definition, or a list of current policing innovations, it is not clear how they should be measured. A few examples demonstrate the complexity of this question. If, for example, closed circuit television cameras (CCTV) were agreed to be an innovation, should adoption be whether or not a police agency had a CCTV system in place, should it measure the number of cameras used, or should it measure the amount of geographic coverage the system accounts for in a particular area. The first measurement of CCTV is a simple dichotomy, but it quickly gets more complicated and it is not always clear which measure is best.

What about community policing which can contain numerous components? The Law Enforcement Management and Administrative Statistics Survey takes on this task by asking numerous questions about community policing. In 2003 LEMAS first asked police organizations whether or not they had: a full time community policing unit, part time unit, dedicated personnel, written policy, or none of the above. Which one these would meet the requirement of innovation adoption? Does the agency need a full time specialized unit in place or would policies suffice? Additionally, LEMAS has a host of other community policing questions: do officers meet with religious group, neighborhood groups, advocacy groups, do they survey public perception, have they partnered with citizen groups, have they trained citizens in community policing, etc. Are there varying levels of innovation? Synthesizing all these variables into one construct would be difficult.

A simple dichotomous measure would alleviate this headache of a task, but this method might remove some of the variability within innovation including numerous cases of partial adoption. This type of adoption occurs when an organization agrees to implement an innovation, but fails to fully adopt all aspects of it. For example, a department might claim to be doing community policing, but in actuality they mostly rely on traditional law enforcement approaches. This is sometimes referred to as shallow adoption where the agency might have small doses of the innovation, but has yet to fully embrace it (Weisburd & Braga, 2006).

Computerized crime mapping is easier to measure than community policing. While it is difficult to tie down specific programmatic elements to community policing (Bayley, 1994), computerized crime mapping is fairly straight forward.

LEMAS further simplifies this process by asking agencies whether or not they use computers for crime mapping—it is a simple dichotomy.

Innovation Categories

Beyond defining and measuring, a third issue sometimes also arises in the literature: can innovations be categorized? Are there unique categories of innovations with different characteristics? Based on Rogers' (2003) discussion of innovation characteristics, this would seem likely. The author explains how different innovations have certain characteristics which make them more appealing to potential adoptions. 1. Relative advantage: how strong of a belief does the potential adopter have that the innovation is better than the current system in place. 2. Compatibility: how similar is the innovation to the practice or tool that it is usurping. 3. Complexity: innovations that are simpler and more easily understood are more likely to diffuse rapidly. 4. Trialability: innovations that can be adopted on a limited basis reduce the risks for the adopter. In Ryan and Gross' (1943) diffusion study, farmers were able to use the hybrid seed on a trial basis thus reducing the consequences of an all or nothing type innovation—if the seed had failed at least they could salvage the rest of their crop. 5. Observability: learning about innovations through communication channels is a critical element in the diffusion process. Innovations that have visible results can initialize the communication process and spread the idea around thus potentially increasing the speed at which it diffuses.

While these characteristics do not provide a specific typology, it does suggest that not all innovations are created equal (Downs & Mohr, 1976). If not all

innovations are created equal they might contain enough uniqueness in them to preclude generalizing associated resource measures to other innovations or innovation categories. In policing such a typology was proposed by Moore et al., (1992). They interviewed 20 "police experts"[3] asking them to categorize innovations. In the end they were able to derive four categories: technological, programmatic or operational, administrative, and strategic innovations. William King (2000) alters Moores' fourfold typology by dividing innovation into five. He separates technical innovations into two categories, ones which enhance line officers law enforcement image and ones which do not. More importantly, King tests whether or not the factors which describe each category are one-dimensional. Using factor analysis he demonstrates how innovations do not fit a fivefold typology since there appeared to be categories within categories. In other words, each category was multidimensional and the fivefold typology fell apart on closer inspection. Therefore innovation cannot be categorized parsimoniously.

There is one main consequence to this finding. Since police innovation is multi dimensional, the results of a study on one particular innovation, computerized crime mapping for example, might not generalize to another innovation, or even other technical or tactical innovations. However, since computerized crime mapping is viewed as having such a strong evidence base, as previously discussed, and since approximately one third of larger American municipal police departments have failed

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[3] The authors identified 30-40 individuals from sitting police chiefs, former police chiefs, police consultants, and academics who study the police. Among this group they were each asked to identify 20 people whose "judgment they would trust about the quality and importance of police innovations over the last decade." The top vote getters, 20 in all, would comprise the final police expert panel.

to adopt it, the importance of knowing the role resources play in its specific diffusion overshadow the potential lack of generalizability.

Summary of Innovation

One thing to learn from this section is that any diffusion of innovation study needs to clearly explain the criteria used in selecting its innovation of interest, particularly if they are using a diffusion of innovation paradigm to study it. Secondly, operationalizing the construct also needs to be carefully considered. While this study is focused on the few who fail to innovate, it still has to deal with the operationalization issue. In order to fail to innovate, it must be clear what qualifies as innovating. A clear line must be drawn between the two. Third, since there is no typology which can be forced upon policing innovation and since there is no universal definition, correlates of innovation should be made on a case by case basis. Researchers and consumers of the extant literature should be cautious when generalizing the results from one innovation to another. However, even though innovation is multi dimensional, careful defining and measuring can begin to reveal trends in the literature.

What Are Resources?

Similar to innovation, problems arise when trying to define and measure resources. Resources can be broadly defined, but generally are some form of support which better enables an individual or organization to innovate. This is general and can include many variables. Luckily, Barbara Wejnert (2002) has constructed a

framework which helps to integrate the myriad of resources that influence the diffusion of innovation process. In her framework she discusses the various forms of resources, or socioeconomic resources as she calls them. This list includes education level, economic well being, cosmopolitanism, gross national product, and level of development. In policing, many studies use similar measures including, but not limited to: budget, department size, community size, human capital, and outside funding. For the current work, similar variables will here after be considered a resource.

Measuring Resources

The measurement of resources is straight forward when compared to the measurement of innovation. Typical measures are usually a ratio level summation. For example, department size will be measured by the number of officers an agency has (Chamard, 2004; King, 1998; Mastrofski et al., 2003) or the rate of officers per given population (Skogan & Hartnett, 2005). The main problem is not that these are incorrect measures, but that studies typically fail to control for the myriad of variables which might be considered a resource. The lack of resource specification leads to several concerns which were addressed in the introduction.

These varying measures of resources appear to be an interrelated group of variables, which has been positively related to innovation (as resources go up so does the likelihood of innovating and as resources decrease so does the probability of innovating) in and out of policing (see Berry & Berry, 1990; Chamard, 2004; Damanpour, 1987; Damanpour, 1991; Kimberly & Evanisko, 1981; Mastrofski et al.,

2003; Mohr, 1969; Rosner, 1968; Skogan & Hartnett, 2005; Walker, 1969; Weisburd et al., 2003). Generally speaking, the logic behind this relationship is that innovations can be costly to implement, therefore supplemental resources are advantageous to have. While innovations can save money in the long run, the initial setup and potential risk deter many potential adopters from innovating[4]. Supplemental resources buffer this risk by offering protection against the use of resources they deem essential and unwilling to risk on an unproven innovation.

Resources and Innovation

Specific measures of resources will now be discussed including a logical argument why each should be considered one, how they are measured, the hypothesized relationship with innovation, and the findings from extant policing literature. Generally speaking, a positive relationship exists between resources and innovation inside and outside of policing, but since it has been suggested that the type of organization can influence this relationship (Damanpour, 1991)[5], the following review will focus exclusively on studies involving police agencies. It should also be noted that this section is not focusing exclusively on those who fail to innovate, which would limit the available literature since studies rarely examine this category of organizations. Finally, a loose definitional approach towards innovation is used in order to select germane studies for this review.

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[4] As noted by Everett Rogers (2003, p. 295) the paradox here is that those who are in most need of the benefits of an innovation (the poor and less educated) are the least likely to innovate first.

[5] Damanpour conducted a meta analysis of diffusion studies and notes that differences in findings exist between private and public sectors and between those who are service based as opposed to manufacturing.

Budget

Innovations cost money, whether you are installing crime mapping software or implementing a new policing strategy, which requires specialized training or the hiring of additional officers. If you are a police chief working with a large operating budget you are probably in the position to take more financial risks, assuming that adopting an innovation is somewhat of a gamble in the sense that you cannot guarantee it will work.

Even if the departments are willing to take the risk, some simply cannot afford to innovate. Chamard (2004) discusses how police chiefs expressed interest in adopting crime mapping, but they were unable to finance it. While budget appears to be a roadblock in Chamard's study, King (1998) found no such relationship when looking at multiple types of policing innovations and slack resources. It is therefore unclear what relationship budget or slack budget has with innovation. A few things should be noted before we conclude that we cannot make any conclusions.

First, as discussed earlier, policing innovation does not fit into specific categories (King, 2000) and perhaps differing innovations have different characteristics and different organizational correlates (Rogers, 2003). Since King (1998) did not include crime mapping among his list of innovations we cannot say that the findings of his study are contradictory with Chamard's (2004) if you take the work of Rogers (2003) and King (2000) into consideration. But since neither study fully addresses the critiques laid out in the introduction, consumers of their work should be cautious to make any interpretation of their results due to omitted variables, spuriousness, and multicollinearity. Moreover, neither study examines the possibility

of resources being a single construct or studies the group of department who fail to innovate.

Outside Funding

Economic resources are not just limited to internal measures. Funding from outside sources which would not be reflected in budget can also provide a push to innovate while mediating the associated risk. When outside funds are supplied to an agency there is usually a caveat attached. This caveat could be referred to as a form of coercive pressure. In Mastrofski et al. (2003) the authors studied several of these outside coercive pressures finding that funding from the Office of Community Oriented Policing exerted the strongest influence on agencies decision to adopt community oriented policing.

Department Size

Certain innovations might require additional officers. If an agency has more personnel to allocate, it is probably in a better position to innovate when compared to an understaffed agency. Imagine trying to implement problem oriented policing with a hot spots context in an agency with a high officer to citizen ratio versus an understaffed agency, the first of which would have a much easier time doing so. A measure of personnel might not be limited to only uniformed officers, but also include civilian staff who may operate geographic information systems and other innovations.

There are two ways proposed in which department size can influence innovation. The above argument assumes that an organization is willing to innovate and that the number of sworn officers *facilitates* this. However, it might be that once a department reaches a critical mass, the size *necessitates* innovation in order to maintain or better manage the structure (Kimberly & Evanisko, 1981). Either way, size matters, but "the important distinction is that organizations may have little choice in the matter: increasing size may create uncertainties that demand innovation behavior" (Kimberly & Evanisko, 1981, p. 699). What is also important to note is that depending on which two links, facilitates versus necessitates, you believe, it might change the way you measure department size. If size facilitates innovation then you can probably use a rate of officers per population served, which probably taps an idea of slack officers, similar to using slack resources. However, if you believe that size necessitates innovation, then you have to measure size in a simple cumulative count. While the purpose of this study is not to identify the mechanism with which size influences innovation, both measures should be considered which might shed light on the facilitates versus necessitates question.

Department size is probably the strongest correlate to innovation with numerous studies finding that larger organizations are more likely to adoption innovations (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003). In her study on computerized crime mapping, Sharon Chamard (2004) found that by far, department size, as measured by number of sworn officers, was the most significant variable explaining adoption. Those agencies with 100 or more sworn personnel were approximately six times more likely to use

computerized crime mapping when compared to smaller departments with fewer than 10 sworn personnel and more than twice as likely to adopt when compared to agencies with 50 – 99 sworn personnel.

In her study population served and number of civilian employees were also related to adoption, but the influence of these resources dropped when controlling for the number of sworn officers. However, the author failed to control for other resources, such as budget, and while noting that her various measures of resources were highly correlated, did not conduct a factor analysis to see if resources was one-dimensional. The correlations between the various measures of resources may be proof of the interrelated nature of resources, at which point, they would probably best be combined into a single measure. Otherwise her study runs the risk of multicollinearity.

Skogan and Hartnett looked beyond a dichotomous measure of innovation in their study on information technology. In one of their models they examined the correlates of the *extent* of adoption finding that more police offers per 10,000 residents was related to an increase in the extent of adoption. This might be evidence of facilitates over necessitates. Weisburd et al., 2003 had similar findings to the prior studies. When looking at agencies who adopted a "compstat-like program", a larger percentage of agencies with 100+ sworn officers adopted the program when compared to with 50-99 sworn officers, 33% versus only 9%. Mastrofski et al., 2003 found that sworn personnel was related to a strategic innovation, community policing, showing it exhibits "considerable influence" (p. 1) on its implementation. This

collection of studies demonstrates the positive relationship between department size and innovation for both the necessitates and facilitates argument.

Community Size

If you serve a large community you will almost invariably require more officers and a larger operating budget, so in this way, budget, sworn officers, and community size are all probably related to each other. It can therefore be difficult to parse out individual effects of each measure, especially if you do not control for all three. Community size might also be related to the types of innovations available to police agencies. Certain innovations, such as computerized crime mapping, are probably more applicable in larger jurisdictions as opposed to a rural town with 200 residents covering five square miles (Weisburd & Lum, 2005). However, many studies are careful to account for this and frequently only examine those police organizations who serve larger communities.

A study of information technology by Skogan and Hartnett (2005) found that those agencies who used the Chicago Police Departments centralized data warehouse, served, on average, a larger population. Conversely, those who failed to adopt served jurisdictions with a smaller population on average. However, the authors did not control for budget or number of officers (relative to community size) in this model[6]. Finally, as previous discussed, Chamard (2004) controlled for community size, but did not find a significant relationship when department size was included in her model. Therefore, it is unclear what relationship community size has with innovation.

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[6] The authors had two separate models, one which simply dealt with adoption versus non adoption and the second which dealt with the extent of adoption.

Both Chamard (2004) and Skogan and Hartnett (2005) were studying technical innovations so you cannot make the argument that they were studying two different types of innovations. It could be the case that correlates must be assessed on an innovation by innovation basis. Another possibility is that neither study fully controls for a wide enough array of resources while also exploring the idea that resources might be a single construct. Therefore, there is not continuity in the findings.

Human Capital

Studies have also looked at those departments who require more education from their recruits. This seems to measure the quality of officer as opposed to the quantity. Highly educated officers might be more versatile in adapting to differing innovations or simply obtain a certain technical expertise which is required of them.

Canter et al., (1988) has elaborated on the impact of higher education on police officer performance with several hypotheses:

1. College education engenders the ability to flexibly handle difficult or ambiguous situations with greater creativity of government.

2. The educated officer is more innovative and flexible when dealing with complex policing programs and strategies such as problem-oriented policing, community policing, task force responses, etc.

3. The officer is better equipped to perform tasks and make continual policing decisions with minimal, and sometimes no, supervision.

4. Organizational change is more readily accepted by and adapted to by the college officer.

Unfortunately the authors fail to substantiate this link. It is therefore unclear what mechanism might lead educated officers to be in a better position to adopt innovations.

Whatever the mechanism may be, a link has been found in the literature. Using this measure in their study on the diffusion of information technology, Skogan and Hartnett (2005) found that agencies with a higher percentage of officers with a college degree were more likely to use the Chicago Police Department centralized data warehouse, which contains information on criminal histories, outstanding warrants, arrest status of juveniles, mug shots, digitized fingerprints, vehicle thefts, traffic violation convictions, and firearms data. Perhaps this is tapping into the educated officer's higher level of technical expertise. But this link is not without detractors. King (1998) had two measures of human capital, formal and profession, neither of which were related the numerous innovations measured in his study.

Summary

The literature generally demonstrates a positive link between resources and innovation, but this link is typically established through single or minimal resource measures. It is therefore difficult to disentangle the role various measures of resources have with innovation. Larger organizations are almost invariably going to have a larger operating budget therefore it is no surprise that investigators have found support for the size of an organization as a correlate of innovativeness (see Mahler & Rogers, 1999; Mytinger, 1968). It seems probable that economics and organization size are linked. Lawrence Mohr (1969) in his diffusion study on public agencies

brought up this exact question. His measure of health department expenditures on innovation was partially related to the community's size. Therefore, it can be difficult to untangle the size of a community or an organization with expenditures. With the absence of department expenditures in the model, community size alone would show a spurious relationship with innovation.

While there is some agreement on the effects of size and budget, there is not a complete consensus. King (1998) and Burns and Wholey (1993) simply find that slack resources have no affect on adoption decisions. In addition, there is also disagreement over the relationship with human capital (King, 1998; Skogan & Hartnett, 2004). What is interesting to note is that both Chamard (2004) and King (1998) have found a significant relationship between innovation and department size, but none of their other resources measures were significant. The differing results could have arisen out of Chamard (2004) and King's (1998) more vigorous measure of resources compared to other studies in policing. Also, part of this lack of congruence could be attributed to the differing definitions and measurements of innovation and resources, thus stressing the importance to have standards for both. However, taking the work of King (2000), it seems that each policing innovation is unique and will produce different correlates regardless of how resources are measured.

With this knowledge, it would be sensible for the current work to be cautious when making generalizations of the research findings. Perhaps it is not realistic to apply these findings to all innovations, but maybe they apply to other technological or tactical innovations within policing. If one thing is clear we do have a better

understanding of how various measures of resources could theoretically be related to innovation.

CHAPTER III: Data and Methods

The literature summarized in the previous chapter generally demonstrates the fewer resources a department has the less likely they are to innovate (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003). Based on this knowledge the following theory will be tested in the current work:

> Police departments who have failed to adopt computerized
>
> crime mapping will have fewer resources than those who have
>
> adopted.

The primary goal of the current work is to better explain the relationship various measures of resources have with those police departments who fail to adopt computerized crime mapping. Various critiques of the extant literature were discussed in the introduction and will now be addressed. In doing so, a better and more complete measure of resources will need to be formed. This section will discuss the data used, variables selected, and analytic strategy employed to address these critiques and better explain the relationship between resources and the failure to innovate.

Data

This study uses data primarily obtained from the 2003 Law Enforcement Management and Administrative Statistics (LEMAS) Survey. Funded by the United States Bureau of Justice Statistics, LEMAS data are published roughly every three years surveying state police, local police, and sheriff's offices. All larger agencies with 100 or more sworn officers are included in the survey, with an additional

representative sample of smaller agencies that have fewer than 100 sworn personnel. LEMAS data sends out questionnaires to the Chief Executive of each agency with a broad range of inquiries from agency size to the adoption of various innovations in policing. Response rates for LEMAS are typically high. In 2003 this overall rate was 94.7% for self representing agencies. Indicators of adoption and non adoption in each agency were obtained using this data set as well as numerous covariates that were hypothesized to be related to innovativeness.

While LEMAS does survey a representative sample of smaller agencies, the innovation used in the current study is more applicable and practical for larger organizations (Weisburd and Lum, 2005). Therefore, this study will largely focus on departments with 100[7] or more authorized full time paid agency positions including sworn personnel with general arrest powers, officers without general arrest powers, and non-sworn personnel. Employees within a department other than sworn police officers should equally be considered a resource since computerized crime mapping does not require an officer with general arrest powers in order to function. Also, due to the nature of the innovation selected and the scope of agency types surveyed, the current work will be largely restricted to not only larger agencies with 100 or more personnel, but also to municipal police departments, which yields a total sample of 649 police departments. These limitations ensure that the innovation is appropriate for all departments in the study. However, using 100 sworn personnel is a bit of an arbitrary cutoff point. Therefore, the current work will also analyze a representative

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[7] Numerous diffusion studies have used a similar cutoff point (King, 2000; Kraska and Kappeler, 1997; Weisburd and Lum, 2005) citing similar reasons to the current works.

sample of smaller agencies with 50-99 sworn personnel in a separate exploratory model.

Aside from the 2003 LEMAS data, additional control variables (see below) are obtained from three ancillary sets, the 2003 Uniform Crime Reports (UCR), the 2003 Bureau of Labor Statistics, and the 2000 United States Census. The Uniform Crime Reports are summary based statistics compiled by the Federal Bureau of Investigation annually through the voluntary submissions of roughly 17,000 law enforcement agencies (FBI). A measure of an agencies crime rate was calculated based on this data. The 2003 Bureau of Labor Statistics provided unemployment data, and finally, the 2000 United States Census provided information on levels of racial and age heterogeneity within the jurisdiction of each police department.

Dependent Variable

As discussed in the previous chapter, computerized crime mapping will be considered an innovation and is the current studies only dependent variable. LEMAS has a very direct measure of this innovation simply asking if the agency uses computers for crime mapping. Certain innovations like community policing have numerous programmatic elements which are difficult to list (Bayley, 1994) and would therefore be difficult to summarize in one measure. However, the operationalization of computerized crime mapping is dichotomous, which avoids some of these measurement issues that would arise with community policing.

Table 1: Failure to Adopt Computerized Crime Mapping

Fail to Adopt	Frequency	Percent
Yes	220	33.9

No	429	66.1	
Total	649	100.0	

Using the most recently available LEMAS data from 2003, roughly 34% of the police departments examined had failed to adopt computerized crime mapping.

Independent Variables

Resources

There are numerous measures of resources which could be related to adoption failure. This thesis will control for a myriad of these in order to better explain the various effects they might have. The following section explains how these resource variables are measured while also providing descriptive statistics for each. Before the various measures of resources are discussed, the idea that budget, department size, and community size might all be measuring the same underlying construct should be addressed.

Table 2: Budget, Department Size, and Community Size

	Fail to Adopt	N	Mean	SD	SE
Budget	Yes	220	25731103	50018675	3372258
	No	429	44924617	191668265	9253831
Department Size	Yes	220	342	691	46
	No	429	617	2680	129
Community Size	Yes	220	115113	194245	13096
	No	429	176234	475556	22960

As discussed in the literature review, it is probably difficult to increase one of these three measures without affecting the others (Rogers, 2003). If a community has a high growth rate a police department might hire more officers to patrol the new communities springing up, and they will probably have to increase their budget to pay

for them. In this example the increasing population of the community causes departments to hire more officers to police them which in turn requires a larger budget. Lawrence Mohr (1969) brought up a similar idea fearing that including similar measures together might lead to multicollinearity. This occurs when highly correlated independent variables are included in the same regression model. It therefore becomes difficult to determine what contribution each measure has in predicting the dependent variable (Bachman & Paternoster, 2004).

It may be the case that *all* resources are part of the same construct, not just the three previously discussed. While budget, department size, and population served, seem to measure the *quantity* of the resource, the two additional resources this thesis uses, formal and professional education, seem to measure the *quality* of the resource. These variables, also referred to as human capital, do not simply aggregate the number of officers a department has, but measure how much education is required for each office, or the quality of each officer. For these measures, it is not how much of the resource you have, but the value of it individually. To determine if there is any empirical justification for the theoretical difference between these two sets of resources, a correlation matrix and factor analysis is presented below.

Table 3: Pearson Correlation Coefficient

	Budget	Population	Size	Formal Ed	Prof Ed
Budget	1	.964(**)	.995(**)	.037	-.004
Population	.964(**)	1	.970(**)	.037	.011
Dept Size	.995(**)	.970(**)	1	.032	-.017
Formal Education	.037	.037	.032	1	.054
Professional Ed	-.004	.011	-.017	.054	1

* No missing cases
** Correlation is significant at the 0.01 level (2-tailed)

All three variables which capture the quantity of the resource, budget, department size, and population served, are highly correlated with each other, and including these in the same model might lead to problems with multicollinearity. Based on the prior literature, these variables are hypothesized to measure a similar underlying resource construct. Factor analysis can provide statistical justification for combining these three measures into one (Hair et al., 1992). Formal and professional education are not correlated and perhaps do not measure the same underlying quality of resource construct.

Table 4: Total Variance Explained

Component	Eigenvalue	% of Variance	Cumulative %
1	2.954	59.083	59.083
2	1.054	21.08	80.163
3	.945	18.89	99.054
4	.043	.854	99.908
5	.005	.092	100.00

*Principal component analysis extraction method

Table 5: Factor Loadings for Component 1

Budget	.994
Population	.985
Department Size	.996
Formal Education	.053
Professional Education	-.004

Table 6: Factor Loadings for Component 2

Budget	-.000099
Population	-.025
Department Size	-.012
Formal Education	.718
Professional Education	.733

Principal component factor analysis extracted two latent constructs with an eigenvalue over one[8]. This appears to offer support for the theoretical discussion above, where certain resources measure quantity and certain measure quality. For the first construct extracted, all three quantity measures load strongly, therefore, these three measures will be standardized and their z-scores will be summed and divided by three to create a new variable in place of the three. Essentially, this creates the average measure of this latent construct. By adding any combination of these three variables into the model without recognizing their high intercorrelation means they run the risk of multicollinearity or spuriousness.

Table 7: Quantity Construct Mean Value for Adoption Failures

Fail to Adopt	N	Mean	SD	SE
Yes	220	-.0872	.364	.02454
No	429	.0447	1.19	.05746

The above table shows cursory evidence that those who fail to innovate have fewer resources. Those who have failed to adopt computerized crime mapping have a lower mean for the new variable just created based on the above factor analysis.

The quality measures of resources load on the second construct, but not the first. Therefore, it appears that these two variables, while considered a resource, are not the same type of resource as budget, department size, and community size. Similarly, these two variables will be combined and averaged into a second resource measure using their z-scores. The first quality measure, formal education, was originally coded as an ordinal scale measuring the educational requirements for new

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[8] A general rule of thumb is to use eigenvalues over one as an acceptable cutoff point. Principal components is used because the goal of the current work is to summarize multiple measures into one latent construct for prediction purposes (Hair et al., 1992).

recruits. Specifically, these are the requirements that new (non-lateral) officers must

obtain within two years of being hired.

Table 8: Educational Requirements Ordinal Scale

4 Four-year college degree required
3 Two-year college degree required
2 Some college but no degree
1 High school diploma or equivalent degree
0 No formal education requirement

Table 9: Human Capital and Computerized Crime Mapping Adoption

Human Capital Requirement	Fail to Adopted		Total
	Yes (%)	No (%)	
4 Four-year college degree required	4 (1.8)	13 (3.0)	17 (2.6)
3 Two-year college degree required	21 (9.5)	26 (6.1)	47 (7.2)
2 Some college but no degree	45 (20.5)	80 (18.6)	125 (19.3)
1 High school diploma or equivalent degree	150 (68.2)	305 (71.2)	455 (70.1)
0 No formal education requirement	0 (0)	5 (1.1)	5 (0.8)
Total	220 (100)	429 (100)	649 (100)

The second quality measure averaged the number of academy and field training hours

required to construct the professional measure of human capital.

Table 10: Human Capital Professional Hours

Fail to Adopt	N	Mean	SD	SE
Yes	220	560.77	375.29241	25.30221
No	429	581.71	309.31715	14.93397

However, as stated above, these two variables were combined based on theoretical

and empirical support into one quality resource construct. What is curious to note

about the table below, is that those who failed to adopt have, on average, more quality

resources, which is not expected based on findings from the previous literature

(Skogan & Hartnett, 2005). This should be interpreted cautiously though, since it is

based on a simple description of the means, and does not account for numerous

control variables.

Table 11: Quality Construct Mean Value for Adoption Failures

Fail to Adopt	N	Mean	SD	SE

Yes	220	.0071	.735	.04957
No	429	-.0036	.722	.03487

Taken as a whole this thesis offers a more comprehensive measure of resources. Budget, department size, and community size, were combined into a quantity of resource construct. Formal and professional education (human capital), were combined into a second quality of resources construct. Therefore, in the current work, a bifurcation of resources is measured among the quantity (budget, department size, and community size) and quality (human capital).

Control Variables

There are two main sets of control variables, organizational and environmental. Beyond the resources an organization has, there are numerous other characteristics of the *organization* which should be controlled for in order to localize the effect of resources on the failure to innovate. Organizational controls operate under to assumption that certain of these measures may promote or inhibit innovation. Everett Rogers (2003) has briefly discussed some of these controls including the level of formalization in an organization, and there is some support in the policing literature for including these control variables (King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005).

Other than the internal organization characteristics such as formalization and specialization, the *environment* in which an organization exists is posited to influence the actions it takes (Wejnert, 2002). Lex Donaldson (1995) has elaborated on the idea of structural contingency theory arguing that organizations are not in a closed system,

they adapt to their surroundings. "The environment is seen as proposing requirements for efficiency, innovation or whatever, which the organization must meet to survive and prosper" (Donaldson, 1995, p. 32).

It is not clear which of these two sets of controls, organizational or environmental, are more important for the current study. Policing scholars have noted that in some cases environmental controls have more explanatory power (Zhao, 1995), but in other instances, organizational controls are the best predictors of innovation (King, 1998; Mullen, 1996). It should be noted that Mullen's findings were based on the adoption of computers, which is more in line with the current studies innovation when compared to Zhao's findings, which were based on the adoption of community policing. Regardless, the current study controls for both organizational and environmental variables—both appear to be important correlates of innovation.

The following section will discuss some of these variables explaining how each can influence innovation and how they are controlled for. Without controlling for these variables it will be more difficult to say with certainty what relationship resources has with the failure to innovate.

Organizational

Formalization

The first organizational control taps into the idea that the type of organizational structure can foster or inhibit innovation. Organizations with highly structured rules or procedures typically hinder the innovation process. Innovation has

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a tough time gaining hold and getting implemented because of a labyrinthine bureaucracy (Rogers, 2003; Thompson, 1965). Using a similar measure to William King (1998), a set of 16 written policies are added to come up with a scale based on each individual dichotomous outcome. The final scale ranges from 0-16 with higher scores presuming to represent more formalized or rigid organizations.

If a department has a formal policy for any of the follow items it was coded as a '1':

Use of deadly force/firearm discharge

Use of less-than-lethal force

Code of conduct and appearance

Off-duty employment of officers

Maximum work hours allowed for officers

Strip searches

Dealing with juveniles

Dealing with domestic disputes

Dealing with the homeless

Dealing with the mentally ill

Employee counseling assistance

Interacting with the media

Off-duty conduct

Citizen complaints

Racial profiling

Pursuit driving

Table 12: Formalization Scale

	Frequency	Percent
6.00	1	.2
8.00	2	.3
9.00	4	.6
10.00	11	1.7
11.00	12	1.8
12.00	44	6.8
13.00	79	12.2
14.00	149	23.0
15.00	166	25.6
16.00	181	27.9
Total	649	100.0

Table 13: Formalization Average

	N	Minimum	Maximum	Mean	Std. Deviation
Formalization	649	6	16	14.37	1.559

Specialization

The second organizational control variable measures how specialized a police department is. Certain departments have specialized units to handle certain tasks such as cyber crime, gangs, and terrorism. It has been proposed that organizations with a higher degree of specialization are more likely to innovate (King, 1998) and there is some empirical evidence to support this claim (Damanpour, 1987; Kimberly & Evanisko, 1981). These separate specialized units are theorized to hold individuals with a wide array of backgrounds which may foster innovation. Also, the fragmentation of a department into specialized units helps insulate them. This insulation protects any innovative ideas they have and allows them to further grow until the point where they can take hold in the organization as a whole (King, 1998).

LEMAS has 22 measures of specialized units, but does not measure whether or not the police department has a specialized computerized crime mapping unit, therefore hopefully avoiding the problem of having a correlated independent and

dependent variable. However, the measure of crime analysis could be contaminated with computerized crime mapping. In other words, certain departments could have a specialized crime analysis unit which performs computerized crime mapping. Therefore, in order to avoid having a correlated independent and dependent variable, crime analysis is removed, and the specialization scale is based on 21 measures, and not 22.

If a department has a specialized unit among the list below, they were coded as a "1". These scores were then summed across all of the specialized units to create an overall specialization scale. The higher the score the more specialized a department is posited to be.

Bias / Hate Crime

Bomb / Explosive Disposal

Child Abuse / Endangerment

Community Crime Prevention

Community Policing

Cyber Crime

Domestic Violence

Drug Education in Schools

Gangs

Impaired Drivers

Internal Affairs

Juvenile Crime

Methamphetamine Labs

Missing Children

Prosecutor Relations

Repeat Offenders

Research and Planning

School Safety

Terrorism / Homeland Security

Victim Assistance

Youth Outreach

Table 14: Specialization Scale

	Frequency	Percent
.00	144	22.2
1.00	12	1.8
2.00	17	2.6
3.00	22	3.4
4.00	37	5.7
5.00	45	6.9
6.00	47	7.2
7.00	41	6.3
8.00	59	9.1
9.00	34	5.2
10.00	49	7.6
11.00	37	5.7
12.00	22	3.4
13.00	17	2.6
14.00	15	2.3
15.00	10	1.5
16.00	10	1.5
17.00	11	1.7
18.00	6	.9
19.00	7	1.1
20.00	3	.5
21.00	4	.6
Total	649	100

Table 15: Specialization Average

	N	Minimum	Maximum	Mean	Std. Deviation
Specialization	649	0	21	6.63	5.19

Environmental

As previously noted by Lex Donaldson, "The environment is seen as proposing requirements for efficiency, innovation or whatever, which the organization must meet to survive and prosper" (1995, p. 32). Weisburd and Braga (2006) have summarized numerous environmental stimuli, which may have motivated the police to innovate, such as empirical studies questioning their effectiveness (see Kelling et al., 1974; Spelman & Brown, 1984), rising crime rates, and issues of police legitimacy. Police departments are probably not a closed system and there are numerous exogenous influences and stimuli which may affect innovation. The next set of variables addresses some of these external influences.

Crime Rates

The first outside factor which might influence innovation is crime. It could be viewed as a challenge for the department to "innovate or whatever" in order to respond to problems in the community. In fact, during the most recent era of dramatic innovation, it has been theorized that many departments were partially influenced to innovate based on this push from crime (Weisburd & Braga, 2006; Weisburd & Lum, 2005). Therefore, the current study will control for this environmental influence by including the crime rate for each department in the year 2003 as reported by the Uniform Crime Reports.

The eight index crimes were included minus arson.

Criminal Homicide

Forcible Rape

Robbery

Aggravated Assault

Burglary

Larceny-theft

Motor Vehicle Theft

The known offenses for 2003 were summarized across the 12 months and then a rate was calculated per 100,000 residents for each location served by the 649 police departments in the sample.

Table 16: Index Crime Rates Per 100,000 Citizens

	N	Minimum	Maximum	Mean	Std. Deviation
Crime Rate	649	1605	66988	8314.3027	4145.98

Racial and Age Heterogeneity

Measures of race and age are included in the model to control for environmental heterogeneity. These variables are considered a measure of social disorganization, which provides an outside influence for departments to innovate (King, 1998; Zhao, 1995). Social disorganization has been linked with crime (see Shaw & McKay, 1969), and crime has previously been argued to be a stimuli to innovate. Therefore, inclusion of racial and age heterogeneity are seen as being germane for the current work.

In a recent study, Skogan and Hartnett (2005) controlled for the percentage of the city which was African-American, finding that cities with a smaller minority population were more likely to innovate, which is contrary to what is expected based

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on social disorganization theory. Perhaps what this implies is that more homogeneous communities produce more homogenous police departments, which are better able to act collectively, and thus innovate. This thesis uses a slightly more sophisticated measure to control for racial and age heterogeneity compared to Skogan and Hartnett (2005), the Gibbs-Martin D Index (Gibbs & Martin, 1962).

The index is a better measure of heterogeneity with categorical data compared to the variation ratio or simple percent minority variable. First, the variation ratio only uses the modal category to base its measure of dispersion. This ignores how much variability there exists between all other non modal categories. Taking a measure of the percentage African-American or White essentially does the same thing. The modal race might be White, with 70% of the cases falling in that category, but that does not mean the other 30% lacks any variation. However, the Gibbs-Martin D Index factors in every category[9].

$$1-\sum p_i{}^2$$

The index takes one minus the summation of the squared proportion of each category, thereby providing some weight to each category. The Gibbs-Martin D Index was used to operationalize heterogeneity of race and age within each jurisdiction the 649 police departments serve. Under this scale higher scores indicate more heterogeneity.

Table 17: Racial and Age Heterogeneity

	N	Minimum	Maximum	Mean	Std. Deviation

[9] Two hypothetical examples help illustrate the index. Assuming the racial composition for town A has a white proportion of .9 and a black proportion of .1. The Gibbs-Martin D Index for town A would be $1 - (.9^2 + .1^2) = .18$. Town B has a white proportion of .9, a black proportion of .05, and a hispanic proportion of .05. The Gibbs-Martin D Index for town B would be $1 - (.9^2 + .05^2 + .05^2) = .185$. Therefore, town B is more heterogeneous using this scale, however, the results of a variation ratio or simple percent white measure would mask the differences between town A and B.

	N				
Gibbs Age	590	.7833	.9117	.8966	.0109
Gibbs Race	590	.0609	.7724	.4171	.1625

*59 missing cases

Unemployment

The unemployment rate for each city was obtained through the 2003 Bureau of Labor Statistics. Previously controlled for in the policing innovation literature (see King, 1998; Zhao, 1995), unemployment is also seen as a measure of social disorganization, which has been linked to crime, which has also been linked to innovation.

Table 18: Unemployment Rate

	N	Minimum	Maximum	Mean	Std. Deviation
Unemployment Rate 2003	649	2.1	16.3	6.328	2.1391

Region

Police departments may not be self contained when it comes to innovation, there may be influences extending beyond the organization itself and even beyond the environment as measured in this thesis. These are larger geographic units than the immediate surroundings as were measured by the previous environmental controls. In the literature, spatial characteristics, such as geographic location within a social network, may influence the decision to innovate (Berry & Berry, 1990; Grattet, Jenness, & Curry, 1998; Rogers, 2003). This could occur through a social learning or imitation process, but discerning this link is not the purpose of the current work. However, it should be controlled for as recommended by Berry and Berry (1990) who

found an interaction between regional influences as well as internal characteristics. The impact of neighboring states on adoption was enhanced when their own internal characteristics, including resources, were favorable to adoption to begin with.

The current work uses the United States Census Bureau's regional divisions to parse the country into nine sections:

Table 19: Census Regional Divisions

Region	Division	States		
Northeast	(1) New England	Connecticut New Hampshire	Maine Rhode Island	Massachusetts Vermont
	(2) Mid Atlantic	New Jersey	New York	Pennsylvania
Midwest	(3) East North Central	Indiana Ohio	Illinois Wisconsin	Michigan
	(4) West North Central	Iowa Missouri S. Dakota	Kansas Nebraska	Minnesota N. Dakota
South	(5) South Atlantic	Delaware Georgia S. Carolina	District of Columbia Maryland Virginia	Florida N. Carolina W. Virginia
	(6) East South Central	Alabama Tennessee	Kentucky	Mississippi
	(7) West South Central	Arkansas Texas	Louisiana	Oklahoma
West	(8) Mountain	Arizona New Mexico Nevada	Colorado Montana Wyoming	Idaho Utah
	(9) Pacific	Alaska Oregon	California Washington	Hawaii

Each police department will be coded from 1-9 depending on what division they are in.

Table 20: Geographic Distribution of Police Departments

Region	Frequency	Percent
New England (1)	58	8.9
Middle Atlantic (2)	91	14.0
East North Central (3)	96	14.8
West North Central (4)	37	5.7
South Atlantic (5)	114	17.6
East South Central (6)	36	5.5
West South Central (7)	65	10.0
Mountain (8)	46	7.1
Pacific (9)	106	16.3
Total	649	100.0

Analytic Strategy

The current study uses a wide scope of resource measures, organizational controls, and environmental controls.

Figure 3: Multivariate Model
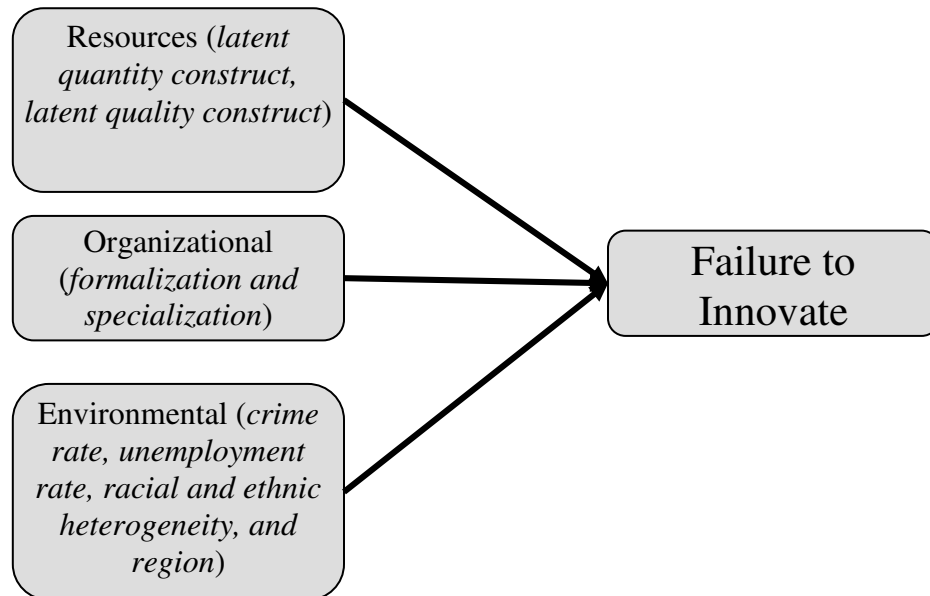
This wide array of measures is necessary to control for confounding variables in order to better discern the link between resources and the failure to innovate. Therefore, because of the wide array of measures, a multivariate approach will be utilized (Kahane, 2008). Since the dependent variable, computerized crime mapping, is a dichotomy, logistic regression is employed under the following model (Weisburd & Britt, 2003):

Logistic Regression Model:

$$P(failure) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_1)}}$$

This equation can be rearranged in order to facilitate interpretation.

$$\ln\left(\frac{P(failure)}{1 - P(failure)}\right) = \beta_0 + (\beta_0 + \beta_1 X_1)$$

The dependent variable indicates the natural log of the odds of computerized crime mapping not being adopted. Exponentiatiating the coefficient will give us the odds of computerized crime mapping not being adopted for each unit increase in our independent variable, which is a bit easier to comprehend than the log of the odds.

Multicollinearity

In order to assess the relationship between resources and the failure to innovate, a multivariate approach is utilized.

"In trying to build correctly specified regression models, researchers are faced with an ironic statistical problem. Even though multivariate regression was developed in part to take into account the interrelationships among variables that predict Y, when independent variables in a regression model are too strongly correlated to one another, regression

estimates become unstable. This problem is called multicollinearity" (Weisburd & Britt,

2003, p. 482).

Multicollinearity occurs when independent variables are strongly correlated with one

another, which leads to unreliable regression coefficients. Independent variables

which exhibit a correlation above .8 are generally considered to be unacceptably high,

at which point, multicollinearity might exist in the model (

Weisburd & Britt, 2003). A correlation matrix is presented below which demonstrates

how none of the current works independent variables are highly correlated (above .8).

Table 21: Independent Variable Correlation Matrix

	Quality Construct	Quantity Construct	Formalization	Specialization	Gibbs Age	Gibbs Race	Crime Rate	Unemployment
Quality Construct	1	.022	.067	.056	-.077	-.153**	-.167**	-.092*
Quantity Construct	.022	1	.091*	.282**	-.021	.187**	-.105**	.090*
Formalization	.067	.091*	1	.180**	-.001	.110**	-.021	.007
Specialization	.056	.282**	.180**	1	-.011	.177**	-.136**	.123**
Gibbs Age	-.077	-.021	-.001	-.011	1	-.032	.159**	.225**
Gibbs Race	-.153**	.187**	.110**	.177**	-.032	1	-.022	.450**
Crime Rate	-.167**	-.105**	-.021	-.136**	.159**	-.022	1	.162**
Unemployment	-.092*	.090*	.007	.123**	.225**	.450**	.162**	1

* $p < .05$ (2-tailed)
** $p < .01$ (2-tailed)

In addition, the variance inflation factors (VIF) and tolerances also indicate

that multicollinearity is not of major concern. All VIF values are below 10 and all

tolerances are above .1, which are suggested cutoff points for determining

multicollinearity (Lin, 2008).

Missing Data

Missing data is a frequent problem for social scientists. Not only can missing data reduce a researcher's sample size and thus affect statistical power, but it is also responsible for a host of problems affecting construct validity, internal validity, and causal generalization (McKnight et al., 2007). The most serious consequences occur when the available data are biased, which may produce different results than if all observations were available (Hawthorne & Elliott, 2004). In the current work two variables contain missing data, the heterogeneity index for race and age. For the heterogeneity indices each variable is missing 59 observations from the same 59 police departments, all of which are located in New England or the Mid Atlantic. Since it is the same departments who are missing data, it is fairly suspect, and these data may not be missing at random (MAR). If, for example, the 59 missing observations are departments who failed to innovate and have an abundant amount of resources, the results of the current work could be very different if these departments are simply dropped from the analysis. Data which is missing completely at random (MCAR) can usually be deleted if it comprises a small percentage of the cases, but in the current work, while missing data comprises only 9% of the observations for each variable, it is not MCAR and therefore should not simply be deleted listwise without further analysis (Schafer, 1999).

Missing data can be problematic when it is related to any of the variables in a model. When the mean values for each variable are compared across the 59 missing observations to the non missing observations, there is no statistical difference

between the dependent variable or quantity resources construct. However, it is related

to the quality construct and some of the control variables.

Table 22: Missing Observations Independent Sample T-Test

	Missing	N	Mean	S.D.	t	S.E.
Failure to Map [u]	Yes	59	.4407	.50073	1.645	.06800
	No	590	.3288	.47018		
Quality Construct	Yes	59	-.1886	.79393	-2.098*	.09889
	No	590	.0189	.71698		
Quantity Construct	Yes	59	-.1324	.25188	-1.075	13543
	No	590	.0132	1.03656		
Formalization	Yes	59	14.406	1.69297	.183	21307
	No	590	14.367	1.54677		
Specialization	Yes	59	4.4407	4.80758	-4.040**	.74258
	No	590	7.4407	5.49663		
Crime Rate [u]	Yes	59	7496.4	2089.04	-2.775**	324.218
	No	590	8396.1	4287.01		
Unemployment Rate [u]	Yes	59	4.917	1.3062	-8.093**	.1918
	No	590	6.469	2.1556		

Region was not included due to the nominal level of measure
[U]: Unequal variances used based Levene's equalities of variances test at .05 level (2-tailed)
* $p < .05$ (2-tailed)
** $p < .01$ (2-tailed)

Since the 59 missing observations are related to some of the variables in the model,

the results of the current work could be influenced by it. Since the missing data could

lead to serious problems affecting the current works research results, further tests

should be conducted to assess its influence.

One method to assess and control missing data are through multiple

imputations. This method involves imputing values for the missing cases, analyzing

each completed data set across multiple imputations, and then aggregates the imputed

data sets into an overall parameter estimate for each variable (Schafer, 1999). This

process hopes to simulate the instability in the model given the missing data. If highly

unstable, the results produced should differ from the initial model which would

suggest something about the models sensitivity. Based on the averages from five

imputed data sets, the estimates produced using multiple imputation did not change the significance of variables in the model when the cases were deleted listwise[10].

One final missing data analysis relies on an implausible scenario. To simulate the most unlikely of circumstances, the highest and lowest values that exist within the reported data were imputed for the missing variables. Separate models were run with the two variables missing 59 cases using various combinations of high high, high low, low high, and low low. The regressions produced by these improbable imputations confirm the results presented in the next section of this thesis. Since there were no changes in the model using this implausible scenario and the multiple imputations, missing data are unlikely to affect the results of the current work.

Sensitivity

Logistic regression assumes that there are no outliers in the data. A sensitive model could be influenced by these observations, which may in turn produce different research results. In order address this potential problem, observations with standardized residuals over 2.58 or under -2.58 ($\alpha = .01$), were removed from the data to assess any changes in the model. Re-running the model after removing outliers did not change the research results. The missing data analysis performed in the pervious section also failed to affect the significance of variables in the model. Therefore, the current model is probably not very sensitive to outliers or missing data.

Various other permutations of variable operationalization were placed in the model to determine their effect. For example, as previously discussed, certain

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[10] Results from the five imputed models are not reported, but it did not differ from the model presented in the results section of this thesis.

measures of resources can be captured as a rate, such as the rate of officers per 100,000 citizens or the departmental budget per number of officers. These rate measures were placed in the model to determine its sensitivity to alternative resource measures. Similarly to the aforementioned missing data analysis, these measures had no impact on any outcomes in the model.

Chapter IV: Results

　　This chapter provides the results of the singular logistic regression model run. This model was used to predict the effect various measures of resources had on the probability of failing to adopt computerized crime mapping while controlling for various organizational and environmental characteristics. Before the results of the multivariate model are discussed, a cursory analysis is run and examined as well.

　　First, a comparison of the means is presented below. The raw data seems to provide some evidence for this documents theory, those who have failed to innovate have a smaller quantity of resources. Non-adopters have, on average, less of the resources construct, which combined budget, department size, and community size. Interestingly, those who have failed to adopt computerized crime mapping actually have more quality resources though. These initial analyses appear contradictory. Failure to innovate was theorized to be related to all resources, but when looking at the mean values, the quality measure is in an unexpected direction.

Table 23: Independent Sample T-Test

	Fail to Adopt	N	Mean	S.D.	t	S.E.
Quality Construct	Yes	220	.0071	.73521	.178	.06026
	No	429	-.0036	.72224		
Quantity Construct [u]	Yes	220	-.0872	.36405	-2.112*	.06248
	No	429	.0447	1.19003		
Formalization	Yes	220	14.2136	1.51546	-1.849	.12906
	No	429	14.4522	1.57690		
Specialization	Yes	220	6.2636	5.65068	-3.017**	.45345
	No	429	7.6317	5.37253		
Gibbs Age	Yes	194	.896684	.01212	.082	.0009
	No	396	.896605	.01030		
Gibbs Race [u]	Yes	194	.392434	.17321	-2.500*	.0146
	No	396	.429176	.15583		
Crime Rate	Yes	220	8286.72	3293.94	-.121	343.79
	No	429	8328.44	4520.2		

| Unemployment | Yes | 220 | 6.364 | 2.1367 | .302 | .1775 |
| | No | 429 | 6.310 | 2.1425 | | |

Region was not included due to the nominal level of measure
[U]: Unequal variances used based Levene's equalities of variances test at .05 level (2-tailed)
* p < .05 (2-tailed)
** p < .01 (2-tailed)

However, a formalized test of these mean differences indicates that the quality resources construct is not significant whereas the quantity is. Those who have failed to adopt computerized crime mapping have a significantly lower score on the quantity resource construct when compared to those who innovated. In other words, they have significantly fewer resources on that one measure. Specialization and racial heterogeneity were also significant and in the expected direction. Those who were more highly specialized and had greater racial heterogeneity were less likely to fail to adopt computerized crime mapping.

The independent sample t-test tells an interesting story about the various measures of resources. While quality resources are not significant, size measures are. The quantity construct was formed by combining budget, department size, and community size. Perhaps these types of sheer volume resources are more important than quality measures. As argued earlier, human capital may measure the quality of the officer, but the quantity construct is partially composed of a count on the number of officers, regardless of quality. In this instance, the quantity of resources appears to matter more than quality of resources.

The next table presents the results of the multivariate analysis. This model includes all measures of resources and all control variables.

Table 24: Multivariate Logistic Regression (N=590)

	Coefficient (S.E.)	Odds Ratio (S.E.)

Quality Construct	.04467 (.13924)	1.0456 (.14561)
Quantity Construct	-.19720 (.22264)	.82102 (.18280)
Formalization	-.01540 (.06025)	.98471 (.05933)
Specialization	-.01624 (.01955)	.98389 (.01923)
Gibbs Age	-1.2070 (8.5348)	.29907 (2.5526)
Gibbs Race	-1.2838 (.74487)	.27697 (.20631)
Crime Rate	.00001 (.00002)	.00001 (.00002)
Unemployment	.03356 (.05160)	1.0341 (.05336)
New England	1.2460** (.40370)	3.4765** (1.4035)
Mid Atlantic	1.2933** (.39233)	3.6450** (1.4300)
East North Central	1.3468** (.34668)	3.8451** (1.3330)
West North Central	.58205 (.44505)	1.7897 (.796522)
East South Central	.06710 (.49690)	1.0694 (.53139)
West South Central	.98881** (.36241)	2.6880** (.97418)
Mountain	.10536 (.44515)	1.1111 (.49462)
Pacific	.78752* (.34151)	2.1979* (.75063)

Log likelihood = -351.0794   Pseudo R2 = 0.0605
South Atlantic was used as the reference category for the region variable
* p < .05 (2-tailed)
** p < .01 (2-tailed)

When controlling for organizational and environmental variables, no measures of resources significantly predict those who fail to adopt computerized crime mapping, and the effects of specialization and race drop out. However, several regional variables are significant. If a department is located in New England, the Mid Atlantic, the East North Central, the West South Central, or the Pacific, the odds of that department failing to adopt computerized crime mapping *increase*, relative to the reference region, the South Atlantic. If a state is located in New England the odds of a department failing to adopt computerized crime mapping are 3.47 times more likely when compared to the South Atlantic. The Mid Atlantic is 3.64 times more likely, the East North Central is 3.84 times more likely, the West South Central is 2.68 times more likely, and the Pacific is 2.19 times more likely, than the South Atlantic, to fail to adopt computerized crime mapping. These results do not provide evidence for the perceived innovativeness of police departments in the West as documented by King

(1998), Mullen (1996), and Zhao (1995). But they do suggest that contagion and social networks could be an important factor in the diffusion of innovations. Departments who are more likely to fail to innovate, when compared to the South Atlantic, appear to cluster in particular regions of the country.

A final analysis is run on smaller agencies that have between 50 and 99 sworn personnel. As previously stated, using 100 sworn personnel as a cut off point was fairly arbitrary, and it might be the case that resources do matter, but only at a certain point. By limiting the sample to all but the largest departments, the current work reduces the variability in the key resource independent variables. Testing the effects of resources while simultaneously removing those departments with less resources, at least smaller ones with smaller department sizes, could affect the results of the current research. Therefore, in order to explore the possibility that resources are related to the failure to adopt, just among a certain segment of departments who have the fewest resources, a second sample of 281 smaller American municipal police departments that have between 50 and 99 sworn personnel is analyzed. Because this is a basic exploratory analysis, the model is limited to resource measures only.

This final analysis utilizes the same resource variables as the previous model: budget, department size, community size, professional, and formal education.

Table 25: Independent Sample T-Test (Smaller Departments)

	Fail to Adopt	N	Mean	SD	t	SE
Community Size	Yes	175	26695	10215	-2.799**	1357.74
	No	106	30496	12264		
Department Size	Yes	175	71	13	-2.520*	1.69120
	No	106	74.92	14		
Budget	Yes	175	524024	2385597	-.996	277415.5
	No	106	5516640	2017046		
Professional Ed	Yes	175	510.377	509.401	-.599	60.001

	No	106	546.320	448.88		
Formal Ed [U]	Yes	175	1.3886	.74886	-1.461	.102
	No	106	1.5377	.87477		

[U]: Unequal variances used based Levene's equalities of variances test at .05 level (2-tailed)
* p < .05 (2-tailed)
** p < .01 (2-tailed)

From a comparison of the means, those who fail to adopt computerized crime mapping have statistically significant fewer sworn personnel and serve a smaller community. While the other resource measures are in the correct direction, none of them are significant. What this seems to indicate, is that while there is cursory evidence for some quantity resource measures, none of the quality measures are significant. These findings are similar to the t-tests run on the sample of larger municipal police departments.

Based on the following correlation matrix, none of the resource measures are highly correlated among this set of smaller municipal police departments, therefore, each variable will be included in the exploratory model without combining them into a singular index.

Table 26: Independent Variable Correlation Matrix (Smaller Departments)

	Community Size	Department Size	Budget	Professional Ed	Formal Ed
Community Size	1	.445(**)	.474(**)	-.013	.092
Department Size	.445(**)	1	.554(**)	.019	-.067
Budget	.474(**)	.554(**)	1	.025	.048
Professional Ed	-.013	.019	.025	1	.007
Formal Ed	.092	-.067	.048	.007	1

* p < .05 (2-tailed)
** p < .01 (2-tailed)

Table 27: Multivariate Logistic Regression (Smaller Departments)

	Coefficient (S.E.)	Odds Ratio (S.E.)

Community Size	-.0000264	(.0000135)	.9999736 (.0000135)
Department Size	-.0229299*	(.011567)	.977331* (.0113048)
Budget	.0000000957	(.0000000794)	1 (.0000000794)
Professional Ed	-.0001583	(.0002492)	.9998418 (.0002492)
Formal Ed	-.2456242	(.1573917)	.7822161 (.1231143)

Log likelihood = -179.30748   Pseudo R2 = 0.0371
* p < .05 (2-tailed)
** p < .01 (2-tailed)

When focusing on smaller departments with 50 to 99 sworn personnel, only department size remains significant in the multivariate model. As department size increases the odds of failing to adopt computerized crime mapping decrease. This finding is consistent with the prior policing literature (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Skogan & Hartnett, 2005; Weisburd et al., 2003). In particular, the effect of community size drops out when department size is added to the model, a similar phenomenon which was document by Chamard (2004). In the current work, department size is the only resource measure significant in either the large or small department multivariate model.

Chapter V: Conclusion

The purpose of this thesis was to better explain the relationship between resources and the failure to adopt computerized crime mapping in larger American municipal police departments. To accomplish this, the current work aimed at addressing several critiques of the extant literature, mostly stemming from inadequate model specification. Based on the classic work from Everett Rogers (2003) and studies by policing scholars (Chamard, 2004; King, 1998; Mastrofski et al., 2003; Mastrofski et al., 2007; Skogan & Hartnett, 2005; Weisburd et al., 2003), it was theorized that those who failed to innovate would have fewer resources. While Rogers (2003) and others have noted the restraints which resources can place on innovation (Chamard, 2004, Mastrofski et al., 2007), this study did not find any significant relationship between resources and those who failed to adopt computerized crime mapping.

The findings of the current work are interesting and unique within the policing literature. With this thesis, a comparison was made between the roughly two-thirds of departments who adopted computerized crime mapping and the one-third who failed to adopt. It is between these two groups where no significant difference in the level of resources, across all measures, was found. However, this does not necessarily indicate that resources have no role in the diffusion of innovations. An exploratory analysis among smaller police departments indicates that department size is a statistically significant predictor of who fails to innovate.

Part of the reason for null findings among larger departments might be due to the construction of the dependent variable. The cross sectional data may have masked

relationships that exist between the earliest adopters and the final few who failed to adopt. This is important as Rogers (2003) notes that any relationships that exist are going to be larger and perhaps more noticeable when dealing with these extremes.

Figure 4: Rogers' Innovator Typology
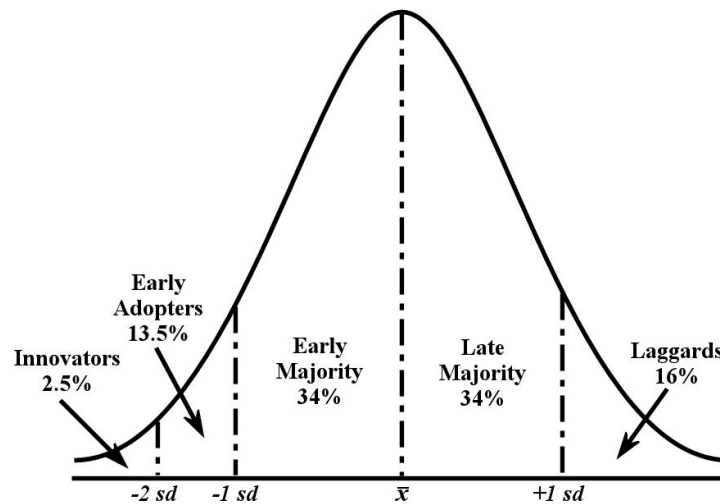
Based on the above categorization of innovators, the current work failed to capture either of the extremes[11]. Roughly 34% of the sample failed to adopt computerized crime mapping, but this is far from Rogers' (2003) 16% laggards category.

Perhaps resources matter in one stage of the diffusion process, but not the other. Maybe for an innovation to gain root it takes a lot of resources, but once the innovation reaches a tipping point, resources are no longer a driving force in its diffusion, and contagion takes over. The current work would therefore conclude that resources are unrelated to innovation once it reaches a mass audience, but this is

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[11] LEMAS is unable to capture many innovators in that it does not ask about innovation early enough in its survey. If innovation X is introduced in policing in 2008, LEMAS will tend to wait a few years before asking about it. In that time frame the innovation has already diffused to a larger percentage of potential adopters making it difficult to parse out who adopted the innovation first. This was the case with computerized crime mapping.

different from saying that resources have no influence at any stage. In other words, the influence of resources may be directly related to time. The longer an innovation is on the market, the less influential resources become.

Arnulf Grübler (1991) has analyzed the diffusion of innovation over time thoroughly by studying the diffusion of various technologies. Grübler uses delta t to identify the time an innovation takes to go from 10% to 90% of a critical mass, or saturation point. The first figure, 10%, is the starting point of Grübler's measure referring to the point in time at which 10% of the target population adopts the innovation. The second figure, 90%, is the stopping point of his clock referring to the point in time when 90% of the target population adopts. The time between these two points is delta t.

Figure 5: Typical Adoption Curve for Successful Innovations

Percentage of Adoption
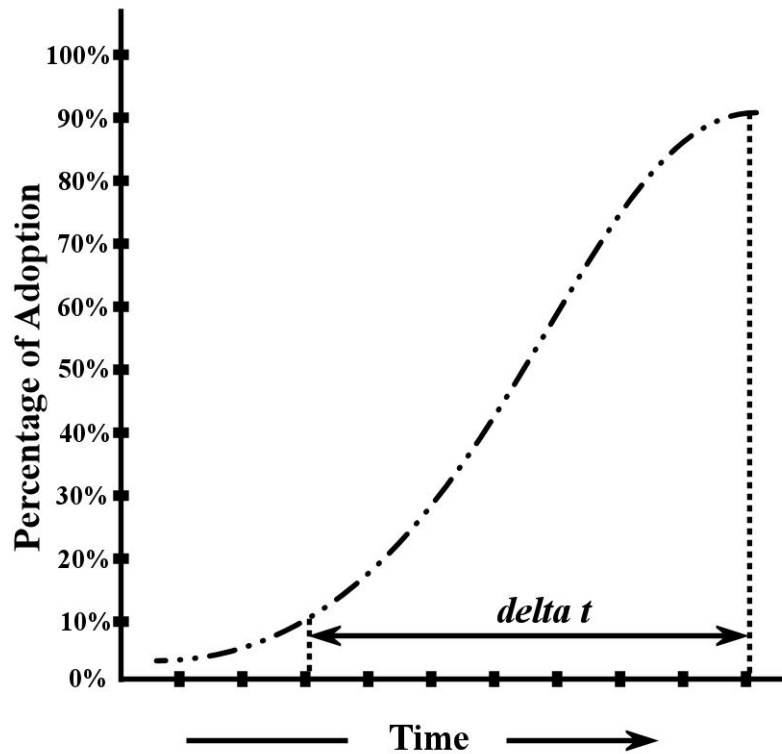
Time

*Adapted from Rogers (2003, p. 11)

Computerized crime mapping has not reached a critical mass, but it would be interesting to study the influence of resources throughout these points of time. The current work was unable to do this due to the cross sectional nature of the data, but future work should attempt to address this issue by studying diffusion and resoruces longitudinally.

There are other problems with the data which may explain the null findings. The cross sectional nature of the data is unable to distinguish between those who adopted at an earlier point, but discontinued, from those who have never innovated. Chamard (2004) documents this phenomenon in her study on computerized crime mapping noting that several departments in New Jersey adopted crime mapping, but then discontinued. Similarly, Mastrofski et al., (2007) found that a few departments in his survey reported to have tried community policing, but then rejected it. If enough

departments discontinued in the current work, the category of those who failed to adopt could be contaminated in a sense. It is no longer filled who those who failed to adopt, but now includes adopters who discontinued. A high level of contamination could affect the research results. A large amount of discontinuers, who may have initially adopted with the help of abundant resources, are now being classified as non adopters. They may therefore mask the effects resources have on those who truly have failed to innovate, or at least those who never tried to innovate.

Using LEMAS data, there was no variation in the levels of adoption among computerized crime mappers. While this made measuring innovation and the failure to innovate easy, it may have also masked variations due to shallow or partial adoption. For example, Skogan and Hartnett (2005) found that human capital was related to a simple dichotomous adoption of the Chicago data warehouse, but department size was related to the extent with which the department used this warehouse. Therefore, different resources are related to different adoption measures. Perhaps the relationship between resources and the failure to innovate only exists when innovation is adopted to the fullest extent. It is not necessarily clear what that extent would be with crime mapping, but regardless, the data did not allow for this type of extent of adoption analysis to be run.

Aside from the restraints of using cross sectional data and the possible problematic construct of the dependent variable, the measures of resources, organizational characteristics, and environmental characteristics, are not exhaustive. For example, outside funding could be influential in implementing an innovation (Mastrofski et al., 2003) and so might cosmopolitanism (Mastrofski et al., 2003;

Skogan & Hartnett, 2005), but LEMAS did not provide a measure of these. Beyond characteristics of the environment and organization, characteristics of the innovation itself are posited to influence the adoption process as well (Rogers, 2003). As previously discussed, the relative advantage, compatibility, complexity, trialability, and observability of an innovation can influence adoption net of resources.

There are also numerous "characters" involved in the innovation process, as discussed by Rogers (2003), which were not included in the final model. For example, the change agent, a person who dedicates their time and energy to ensuring a particular innovation is adopted. In Skogan and Hartnett's (2005) study on diffusion of the Chicago Police Department's data warehouse, such a person existed. A retired police officer contacted each agency they were trying to convince to innovate, visited most of them, and gave a presentation on how to use the database. Few innovations receive this kind of support from one single person and in the current study, it is unknown if such a person existed to help computerized crime mapping diffuse. This type of outside influence could trump the role resources play.

Validity of Data

Aside from missing control variables, there are concerns about the data actually available. The Law Enforcement Management and Administrative Statistics Survey is an invaluable source to anyone interested in studying police agencies. The high response rate, scope of agencies surveyed, and breadth of questions asked are just some of the strengths. However, there is one main concern about the validity of the data. Data collected from each agency is based on a single survey sent to the chief

executive of the agency who may delegate its completion to whomever they see fit (Reeves, 2006). In other words, LEMAS uses a single informant to collect information on literally hundreds of variables. There are a multitude of problems with using this method of data collection, the first of which is the potential positional bias the chief executive may have in completing the survey. LEMAS data are publicly available therefore a police executive may be less scrupulous in completing the survey in order to place their department in a better light, seem more progressive than they actually are, or maintain a certain status quo. Moreover, and probably more of a threat to validity, is the fact that the executive may not even be the most well informed person to fill out the survey. They may have a lack of knowledge in certain areas of their agency and therefore their answers may not accurately reflect the agency.

There are far better methods of gathering data from police departments than relying on a single informant, one of which is the key informant approach. Key informants are chosen based on certain qualifications which place them in a position to respond to questions asked in a survey. For example, Weisburd and Lum (2005)[12] sought out individuals in an agency with knowledge of computerized crime mapping, and sent their pilot survey to them instead of directly to the chief, who may not have the same technical expertise to answer all the questions asked. Another example would be to use a multitrait-multimethod design where you have multiple respondents who assess one variable using different measures. This adds a few checks into the

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[12] Weisburd and Lum (2005) have found discrepancies when cross checking the LEMAS data with a database collected by the Crime Mapping Research Center.

process and helps to triangulate answers using multiple sources and multiple measures.

Generalizability

It has been suggested that singular innovation studies, like the current work, may only be related to one part of an organization, whereas other types of innovations would be related to other parts of the organizations function (Damanpour, 1987). In policing, technological innovations may strictly be related to organizational factors (Mullen, 1996), whereas strategic innovations might be related to environmental factors (Zaho, 1995). There are only a handful of studies on the diffusion of innovation in policing (Weisburd & Braga, 2008), so little is known about the continuity of correlates among various policing innovation types. Therefore, the results of this work should carefully be applied to innovations in general.

Future Considerations

While the current work only employed one dependent variable using one specific type of innovation, it would be interesting to see if the results hold up using multiple innovations in separate models, or some aggregated "innovativeness" measure (see Weiss, 1997). King (1998) has noted that policing innovations do not fit into parsimonious categories as discussed by Moore et al., (1992), but when considering the characteristics of relative advantage, compatibility, complexity, trialability, and observability, as discussed by Rogers (2003), it seems likely that there is individual uniqueness to each policing innovation regardless of any

categorization attempt. Therefore, it is seems possible that different innovations are adopted for different reasons and different organizational and environmental factors may be influential in this adoption given the varying characteristics of each innovation. Perhaps less compatible innovations require more resources to transform the organization, but the influence of these innovation characteristics is currently unknown.

As discussed previously, future work should also look at innovation longitudinally. The current work analyzed the relationship between innovation and resources, but only after a significant proportion of potential adopters innovated. A more important question to policing scholars might be how to get an innovation to reach this tipping point where Grübler's s-curve "takes off". To really influence whether or not an innovation "succeeds", in terms of reaching delta t in the shortest possible time, it may be more important to know what influences innovation initially.

A final future consideration, which the current work was unable to address, is the role of social networks. The current work uncovered what appears to be a geographic clustering of the departments who fail to adopt, which could support the idea that innovations spread, or departments resist change, through contagion. Organizations and individuals who are in closer contact, presumably influenced by geographic constraints, are likely to develop similar ideas, beliefs, and values. These individuals and organizations become linked in a network and because of this, innovations can spread rapidly to a large group of people, who tend to act collectively. This might explain why certain regions of the country are more likely to fail to adopt computerized crime mapping. These regions networked police

departments might currently be resisting innovation, but this also means, if they are networked, that computerized crime mapping has the potential to quickly diffuse among them through contagion.

In their seminal work on the diffusion of innovation, Ryan and Gross (1943) found that communication with salesmen and neighbors were highly influential in the diffusion process of hybrid corn seed. Adopters primarily learned of the innovation through salesmen, but as time went on their neighbors became more influential in their decision to adopt. The authors were also able to map out the diffusion process, illustrating how certain farmers acted as, what Malcolm Gladwell would call, connectors (2002). There farmers were able to learn of the innovation outside of their small farming community from an agricultural scientist, but then spread this knowledge to many of their peers. Connectors tend to link people who would otherwise be isolated from each other. Innovations and ideas tend to spread faster when they reach highly connected people. Gladwell illustrates this point by retelling the story of Paul Revere's midnight ride. While Revere, a highly connected and influential colonist was able to mobilize towns he passed through, of the incoming British Red Coats, his counter part, on a similar midnight ride, William Dawes, was unable to. Dawes was unknown in the communities he rode through and more importantly did not know the right people in town to contact—Dawes was not connected. Whereas Revere would ride into a town and knock on the door of the local militia leader, Dawes would knock on the random doors of strangers. The question in the current work would be to identify the connectors in policing and understand what role they have in the diffusion of innovations.

Summary

All things considered, what do the findings mean? Despite the concerns voiced in the previous paragraphs, only the t-test's showed any link between resources and the failure to innovate among larger American municipal police departments. These initial results vanished in the multivariate model. It would seem logical that if you have more resources you would be more willing to adopt a risky new program or tool, but this does not appear to be the case. Resources are no quick route to innovation. Simply increasing the budget or department size will not lead to innovation because there is probably a more complex process involved.

Police departments in America have embraced numerous innovations in recent decades including such changes as community policing, broken windows, hot spots, and compstat. These innovations have not just diffused in a particular geographic region or among a specific subculture of organizations, but have become a ubiquitous part of the countries overall policing paradigm (Weisburd and Braga, 2006). The current work hoped to increase our understanding of what influences this diffusion. But the process of diffusion in policing is not understood well and will require more attention in the future.

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