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## The Response Of American Police Agencies To Digital Evidence

Hamdi Yesilyurt

University of Central Florida, [hyesilyurt@knights.ucf.edu](mailto:hyesilyurt@knights.ucf.edu)

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THE RESPONSE OF AMERICAN POLICE AGENCIES  
TO DIGITAL EVIDENCE

by

HAMDI YESILYURT

B.S., Police Academy, Turkey, 1999  
M.S., Eastern Kentucky University, 2005  
M.S.D.F., University of Central Florida, 2010

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for the degree of Doctor of Philosophy  
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Major Professor: Thomas T. H. Wan

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## **ABSTRACT**

Little is known about the variation in digital forensics practice in the United States as adopted by large local police agencies. This study investigated how environmental constraints, contextual factors, organizational complexity, and organizational control relate to the adoption of digital forensics practice. This study integrated 3 theoretical perspectives in organizational studies to guide the analysis of the relations: institutional theory, contingency theory, and adoption-of-innovation theory. Institutional theory was used to analyze the impact of environmental constraints on the adoption of innovation, and contingency theory was used to examine the impacts of organizational control on the adoption of innovation. Adoption of innovation theory was employed to describe the degree to which digital forensics practice has been adopted by large municipal police agencies having 100 or more sworn police officers.

The data set was assembled primarily by using Law Enforcement Management and Administrative Statistics (LEMAS) 2003 and 1999. Dr. Edward Maguire's survey was used to obtain 1 variable. The joining up of the data set to construct the sample resulted in 345 large local police agencies.

The descriptive results on the degree of adoption of digital forensics practice indicate that 37.7% of large local police agencies have dedicated personnel to address digital evidence, 32.8% of police agencies address digital evidence but do not have dedicated personnel, and only 24.3% of police agencies have a specialized unit with full-time personnel to address digital evidence. About 5% of local police agencies do nothing to address digital evidence in any circumstance. These descriptive statistics indicate that digital evidence is a matter of concern for most large local police agencies and that they respond to varying degrees to digital evidence at

the organizational level. Agencies that have not adopted digital forensics practice are in the minority.

The structural equation model was used to test the hypothesized relations, easing the rigorous analysis of relations between latent constructs and several indicator variables.

Environmental constraints have the largest impact on the adoption of innovation, exerting a positive influence. No statistically significant relation was found between organizational control and adoption of digital forensic practice. Contextual factors (task scope and personnel size) positively influence the adoption of digital forensics. Structural control factors, including administrative weight and formalization, have no significant influence on the adoption of innovation.

The conclusions of the study are as follows. Police agencies adopt digital forensics practice primarily by relying on environmental constraints. Police agencies exposed to higher environmental constraints are more frequently expected to adopt digital forensics practice. Because organizational control of police agencies is not significantly related to digital forensics practice adoption, police agencies do not take their organizational control extensively into consideration when they consider adopting digital forensics practice. The positive influence of task scope and size on digital forensics practice adoption was expected. The extent of task scope and the number of personnel indicate a higher capacity for police agencies to adopt digital forensics practice. Administrative weight and formalization do not influence the adoption of digital forensics practice. Therefore, structural control and coordination are not important for large local police agencies to adopt digital forensics practice.

The results of the study indicate that the adoption of digital forensics practice is based primarily on environmental constraints. Therefore, more drastic impacts on digital forensics practice should be expected from local police agencies' environments than from internal organizational factors. Researchers investigating the influence of various factors on the adoption of digital forensics practice should further examine environmental variables. The unexpected results concerning the impact of administrative weight and formalization should be researched with broader considerations.

This dissertation is dedicated to my wife, Evrim and my daughter, Sila.

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## **CHAPTER I: INTRODUCTION**

### **Focus**

American police agencies have used digital forensic evidence for several years, although police agencies have been using modern forensics techniques for centuries. Digital forensics practice is a broad concept that involves all aspects of digital evidence processing. However, it is unclear to what degree police agencies use digital forensics.

This study investigated the factors influencing the variation among police agencies in digital forensics practice. Only large police agencies were included because their policies demonstrate great variation in approach. The correlates of digital forensics practice adoption in this investigation include environmental constraints, contextual factors, and organizational control.

### **Nature**

Police agencies have been analyzed from many angles, including how and why they adopt police practices and address community problems. The power of police agencies to enforce laws and this power's impacts on people bring police agencies under public scrutiny. How best to structure police agencies to alleviate problems has been disputed for several years. Because most of these discussions have not been empirically based, they have left too much room for ambiguous postulations (Langworthy, 1986). Scholars such as Duffee (1980) and Maguire (2003) noted the importance of understanding how police agencies operate and the reasons for establishing varying solutions at varying organizational controls. These scholars pointed out that although many claims and myths exist about changes in police organizations, the variation in the



structure and function of police organizations ought to be examined based on empirical evidence and research. Failure in this approach may cause inefficiencies and ineffectiveness in police agencies.

### **Importance**

There are a few things in society that does not get older or become outdated. Innovation is certainly one of them. Therefore, the importance of innovations should not be disregarded at any age. The present study focuses on innovation and is important for the following reasons. First, identifying the relations between organizational factors and digital forensics practice adoption as an innovation reveals the principal reasons behind the varying levels of digital forensics practice adoption. Second, by assessing the variations in digital forensics practice on empirical bases, the study enables the identification of organizational trends in local police agencies' adoption of digital forensics practice as well as organizational constraints influencing forensics practice. Acquiring knowledge about the underlying concepts related to both police agencies and digital forensics practice also provides a resource for decision makers, who in many cases are police executives or mayors, and shows how their environments influence decision making in local police agencies. Last, the quest to research on identifying and examining organizational factors and environmental constraints is still in its early stages for the criminal justice field. More empirical research will contribute to the development of organizational studies in the field of criminal justice.

### **The Scope of the Problem**

#### **Technology and Crime**

Our daily lives contain many forms of technological development. Each year a number of new devices, products, and services are presented to society. By the time society comprehends

these products and services, a new version of them becomes available with different models and features. For example, cell phones, iPods, Voice over Internet Protocol (VoIP), personal video phones, videoconferencing, and many other information technologies that use communication networks have numbered among the last few decades' innovations.

The Internet has become a significant part of our lives. Both organizations and individuals can share information, access bank accounts, send electronic posts, pay bills, receive education online, or participate in online games and leisure activities. Web sites such as Facebook, Twitter, and Myspace have become important ways of networking that allow people to follow each other's actions. Moreover, many industrial organizations, sports clubs, and news channels have been communicating with their followers on the Internet. Our social life had been solely based on nature and traditions for thousands of years. Now it is moving at an incredible speed toward reliance on digital platforms. Needless to say, all of these changes are based on technology, and the demand for the use of technology by citizens and government has been staggering.

The 21st century has brought us into a new era that has improved quality of life; nevertheless, this could be considered a "double-edged sword" (Gordon, Hosmer, Siedsma, Rebovich, 2002, p. 7). Although technology serves the needs of the community, it also enhances the capability of criminals (Gordon et al., 2002). For criminals, a new technological development means new opportunities and tools are readily available, helping them to victimize their prey. Technology has been used as a basis for all types of crimes involving computers, including infiltration of protected systems, espionage, identity theft, fraud, child pornography, and child

exploitation. Technology brings new complications to police organizations every day, especially via the Internet (Smith, 2008).

Federal law criminalizes all of the activities listed above; nonetheless, criminalizing such activities is not enough (Smith, 2008). Criminalization only has symbolic meaning for society unless police agencies address the problem specifically with their practices. The increasing amount of digital evidence is becoming an excruciating problem for society and police agencies. Therefore, the changing technological environment drives police agencies to embrace these technologies and develop contemporary approaches and solutions to processing digital evidence.

### **Digital Forensics Practice**

The recent technology boom and substantial use of computers on a daily basis have been complemented by an increasing quantity of digital evidence<sup>1</sup> (Busing, Null, & Forcht, 2005). Digital evidence is brought to the judicial system through digital forensics practice. Digital forensics practice is a recent branch of forensic science that has the same goals as traditional forensics science in terms of serving the legal system but uses a different set of tools, techniques, and processes. While the field of digital forensics practice comprises every practice related to digital evidence, this study concentrates on digital forensics practice as adopted by police agencies, which are the major practitioners of digital forensics in dealing with digital evidence.

The United States' federal system of government and its willingness to leave the control of criminal matters to local administrations have led to the establishment of independent forensics laboratories, which has prevented the establishment of nationalized forensic laboratories in the United States (Saferstein, 2009). As a result of this circumstance, processing

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<sup>1</sup> "Digital evidence is information and data of value to an investigation that is stored on, received, or transmitted by an electronic device" (National Institute of Justice, 2008, p. ix).

digital evidence caused digital forensics practice to emerge as part of the criminal justice system (Busing et al., 2005). Demand by law enforcement agencies and private businesses significantly improved the establishment and development of digital forensics practice in America (Noblett, Pollitt, & Presley, 2000). Digital forensics practice is implemented in either digital forensics labs or environments similar to traditional forensic labs that separate evidence processing from investigative areas of police agencies. However, police agencies' varying organizational attributes modify the applications of digital forensics practice in terms of their degree of establishment, as local police agencies demonstrate great variation in governance perspective in the U.S. For example, in one police agency we may see a computer forensics lab established with strict regulations, while in another police agency digital forensics is practiced in a small office by a couple of digital forensic investigators with a few tools.

### **Police Agencies**

Criminal justice is a broad-spectrum field that deals with many crime-related problems of society. Thousands of independent police agencies have been serving their communities' expectations with various solutions in America. As the technological complexity of society increases, polices are also expected to be able to solve more complex criminal technology matters. The proximity of municipal police agencies to communities and their degree of responsibility and capacity to enforce the law make them the first place for seeking justice and order for citizens, as does constitutional devolvement of authority to the states and localities. Hence, this study focuses on municipal police agencies.

American police agencies are highly decentralized and constrained by their jurisdictional environments. According to the 2004 Census of State and Local Law Enforcement Agencies

(LEMAS), 17,876 state and local law enforcement agencies were then serving in the U.S. The 12,766 local police departments constitute the biggest part of law enforcement agencies, followed by 3,067 sheriffs' offices and 49 primary state law enforcement agencies. Local police agencies serve the country with 1.1 million full-time personnel, including 732,000 sworn personnel and nearly 105,000 part-time employees, of which 46,000 are sworn officers. The majority of state and local law enforcement agencies have fewer than 10 officers, which accounts for just 5% of all sworn officers. Only 6% of agencies employ 100 or more officers, and these agencies constitute almost two thirds of sworn personnel. These 6% of local law enforcement agencies are the specific focus of this study.

### **Purpose**

It is a well-known fact that policing is decentralized in the United States. This study aimed to investigate the source of variations in the adoption of digital forensics practice. Key theoretical constructs, to be operationally defined at a later point, include environmental constraints and organizational factors along with organizational control. Four phases of analysis were formulated. First, a descriptive approach was used to illustrate the variation in adoption of digital forensics practice among this minority of local policing agencies. Second, the relation between environmental constraints and adoption of digital forensics practice was analyzed. Third, the influence of contextual factors on adoption of innovation was explored. Fourth, the relation between organizational control and adoption of innovation was studied.

### **Outline of the Study**

The first chapter presents an overview of the study of the adoption of digital forensics practice by municipal police agencies in America, which constitute larger police agencies in

terms of their sworn personnel size while they represent a smaller proportion of police agencies. The second chapter includes the theoretical framework, in which numerous examples of police practices were identified and exemplified in order to illuminate from whence this study inherits its approach. The third chapter covers the information necessary to construct the measurement model of the study. In the fourth chapter of the study, understanding digital forensics practice and digital forensics practice as adopted by police organizations is elucidated with an emphasis on digital evidence, cybercrimes and the incidental value of digital forensics practice, characteristics of digital forensics practice in police agencies, and investigations of cybercrimes and digital evidence. In the fifth chapter, the method section describes data collection and analytical methods. The sixth chapter explains the findings, while the seventh chapter, which is the conclusion chapter, reiterates the findings while discussing the conclusions and implications of the study.

## CHAPTER II: THEORETICAL FRAMEWORK

### Introduction

The purpose of this chapter is to explain the theoretical background of this study. This chapter begins by identifying organizations and the importance of empirical studies in organizational research in general, and then discusses the relevant literature regarding local police agencies. More specific theoretical concepts relevant to the present study are explained in the next chapter. The first part of this chapter addresses and embraces an open systems perspective. The chapter also presents a review of relevant theoretical frameworks to guide the study. Three organizational perspectives are used to explain the variation in adoption of digital forensics practice. By integrating three different theoretical views—the institutional theory, the contingency theory, and the innovation theory—this study uncovers the structural relation of the correlates of the adoption of digital forensics practice.

### Organizations

Lawrence and Lorsch (1967) defined *organization* as a “system of interrelated behaviors of people who are performing a task that has been differentiated into several distinct subsystems, each subsystem performing a portion of the task, and the efforts of each being integrated to achieve effective performance of the system” (p. 3). Scott (1998) claimed that organizations play a significant role in and generally have a considerable effect on society. Scott (1998) viewed organizations as “social structures created by individuals to support the collaborative of specified goals” (p. 10). According to Selznick (1984), organizations in the United States are usually self-governing, meaning several tasks are independently managed as these organizations are responsible for managing large resources.

All of the above definitions include important aspects of organizations. Depending on the political culture, which in the case of this study is defined by the U.S. Constitution (together with state constitutions that govern county and local policing agencies), organizations may present certain behaviors aimed in a particular direction at different phases of the organization's development. Selznick (1984) emphasized this difference in America by noting that organizations are usually self-governing, as opposed to utilizing centralized management. In contrast to U.S. decentralization and emphasis on independent organizational management, organizations in other countries may present less variation. The decentralization of government institutions in the U.S. federal system presents an important opportunity to examine the variety in organizations and draw varying conclusions based on different system-management applications.

As with most organizations in the United States, police agencies are relatively self-governing and decentralized as compared to most contemporary police agencies in developed countries. The Census of State and Local Law Enforcement Agencies (2004) indicates that there are 17,876 state and local law enforcement agencies in America, which indicates the decentralization and self-governing nature of police agencies. Further sections of the present study will review police agencies' governing methods and their autonomous control.

### **Empirical Study**

It is a challenging task for organizational scholars to write rationally coherent and incorporated arguments (Sutton & Staw, 1995). Numerous researchers, based on paradoxical theoretical claims, have tried to explain the existence of "empirical relations" between variables. The trend toward following theories utterly without strict empirical tests has contributed to



contradictions among the findings of researchers. Researchers' misapprehensions also lead to conflicting results in empirical studies (Westie, 1957).

Good empirical research not only tests theory but also helps build it (Merton, 1948, p. 506). Empirical research must be active in the sense that it initiates, reformulates, redirects, and clarifies theory. It initiates with new hypotheses that have not yet been adequately researched, reformulates these neglected concepts with constant observations, helps refocus researchers with new procedures and data, and finally clarifies loosely defined concepts to advance the available research (Merton, 1948). As a true criminal justice theory should explicate the criminal justice system's reaction to a behavior and not the genesis crime per se (Snipes & Maguire, 2007), so should the empirical study of police organizations explain the behavior of police agencies. In essence, researchers must use their ability to "stimulate questions rather than simply answers" (Wan, 2002, p. 3) in order to understand the criminal justice system.

The criminal justice system comprises many different behaviors and activities, which makes a theoretical approach to the criminal justice system interdisciplinary. As a matter of fact, the criminal justice system is more of an "official response to crime" (Duffee & Maguire, 2007, p. 32). Criminal justice researchers should be concerned about "what criminal justice does" rather "what it hypothetically can do" (Langworthy, 1986, p. 13). Policing does not have its own theories; as a part of the larger criminal justice system, it obeys the same political and popular principles. Researchers need to be concerned with matters of policing from a normative perspective (Miller, Blackler, & Alexandra, 1997). Considering all of the implications of

normative theories, this study follows a normative<sup>2</sup> approach wherein police agencies' organizational attributes are examined in terms of what they actually do rather than what they ideally should do.

### **Rationality**

Organizational theorists perceive organizational compositions rationally and approach the normative features of organizations by comprehending “specificity of goals and the formalization of rules and roles” (Scott & Davis, 2007, p. 56). The term *rationality* reflects the idea that organizations function systematically to obtain prearranged goals with the greatest effectiveness (Scott, 1998). The focus of rationality, which is based on the formal rules and principles of organizations (Feeley, 1973), is not how the goals are set but rather how they are applied to the organizations (Etzioni, 1960; Scott, 2007). Using a Weberian model, police administrations are conceived as “rational-legal” bureaucracies that manage internal processes and discipline the organization to carry out specific goals (Manning, 1997).

### **Open Systems**

Organizational systems are primarily defined as open or closed systems, yet each system includes some properties that make it both open and closed, which means there is no exact boundary that makes an organization completely closed or open. For example, the fact that organizations cannot respond to all the demands of their environment makes them in that sense closed systems (Roberg, 1979).

Until the spread of system theory, most scholars perceived organizations as closed systems. One of the factors leading to this approach was that police agencies were incapable of

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<sup>2</sup> According to Scott (2008), normative structures both constrain social behavior and endow certain rights to perform social behaviors.

responding to the varying claims and demands of their communities. Therefore, this situation caused such government services to be considered closed systems (Gaines & Kappeler, 2003). The intensification of nonroutine and unstable police work, along with the increase in police agencies' capacity, ended the course of the closed-systems perspective, and the open-systems perspective became a popular preference of public managers (Cordner, 1978).

The ability to exchange resources internally and externally has also contributed to the spread of the open systems perspective (Anderson, 1999). According to the open systems perspective, the components of organizational systems vary. Organizational systems' components epitomize varying degrees of complexity, stability, and reactivity from minimum to maximum (Scott & Davis, 2007). The open systems perspective contends that the elements of systems are only weakly connected and are capable of quite independent actions (Ashby, 1968). Although an organization may be highly autonomous as an open system, loose coupling in structural arrangements can be highly adaptive for the system as a whole (Orton & Weick, 1990). In essence, each party in an organization relies on the others under the general rubric (Scott, 1998, p. 10).

The open systems view notes the importance of interconnectedness between an organization and its environment. An organization's environment includes everything but the organization itself (Maguire, 2003). Preexisting views about environment were rejuvenated and intermingled in the context of open systems, starting from the mid-1960s (Scott, 2008). According to Scott, environment of organizations can "constraint, shape, and renew the organization" (2008, p. x). Little more than a decade later, the criminal justice field started

recognizing the importance of environment and its influence on police agencies in the context of the open systems perspective.

Police agencies deal with problems of their environment that are directly or indirectly related to crime. For instance, a wide range of issues, such as homicide investigations and community problems, fall under the interest umbrella of police agencies. Police agencies are expected to overlap their task with their environment, which many times brings constraints. In order to deal with the specifics of their environments, police agencies interrelate their practices with their environments and frequently expose the outside world's influences on their varying tasks.

Complying with the open systems perspective, digital forensics practice may show differing degrees of complexity, stability, and reactivity. Digital forensics deals with mainly three types of digital evidence: evidence that is the subject of computer targeted crimes, evidence that has instrumental value for traditional crimes, and evidence that has incidental value for traditional crimes(Clark & Diliberto, 1996). As dealing with cybercrimes is specifically the primary task of digital forensics units in police agencies, we may observe loose coupling and less interdependence between digital forensics units and their organizational environments. Essentially, dealing with the computer targeted crimes (hacking or compromising computers) requires highly advanced knowledge of information technology, (IT) and this category of cybercrimes induces less interest in other components of police organizations. In contrast with cybercrime investigation that deals computer targeted crimes, the instrumental and incidental value of digital evidence in criminal incidents entails more bonds between digital forensics units and other components of police organizations. These alternative situations concerning digital

forensics units in police organizations comply with Scott’s (1998) contention that the interdependence of components in organizations may vary.

### **Theoretical Framework**

Under the rubric of an open systems framework, this study embraces three theoretical approaches, which are indeed the three dominant theories of organizational research: contingency theory, institutional theory, and diffusion of innovation. As shown in Table 1, at first contingency theory is employed in this study to comprehend the organizational control of local police agencies and contextual factors influencing police organizations. Second, utilizing the institutional theory, the study analyzes the effects of external dynamics on police agencies. Third, using diffusion of innovation theory, the study explicates the degree to which digital forensics practice was adopted and the extent of its spread in police agencies.

Table 1: The Theoretical Framework and the Identifying Concepts of DFP

<b>Contingency Theory</b>	<b>Institutional Theory</b>	<b>Adoption-of-innovation theory</b>
Contextual Variables	Environmental Constraints	Degree of Adoption of DFP (Incremental to Radical)
Organizational Control		

In order to theoretically explain the organization of police agencies, this study will theoretically address the general context of organizational studies and then move to their applications in the criminal justice system by giving examples of major criminal justice approaches in the literature.

### **Systems Era**

According to Wan (2003), a *system* is a framework, dedicated to practicing certain tasks

in order to reach prearranged objectives, that is subject to the allocation and limitation of resources. A given system may include personnel, materials, facilities, and information (p. 1). Ackoff (1974) defined the era after the 1940s as the *system age*. He mentioned that larger purposeful systems consist of groups and units as their parts. System management is concerned with the purpose of the system, where each subpart of the system individually has its own purpose serving within the cluster. Ackoff (1974) contended that a study of systems facilitates the effectiveness of organizations “for their own purposes, the purposes of their parts, and the purposes of the larger systems” (p. 3). Organizations are complex at several levels, and they establish their goals and move on (Van Gigch, 1978). Systems theory considers humanity and its surroundings as a fraction of interacting systems. The goal of systems theory is to study interactions from multiple perspectives (Skyttner, 2001).

In contrast to many schools of organizational study, design theory is pragmatic and applied. Design theorists use the administrative view concerning the development of organizations, which was categorized under open systems perspective (Scott & Davis, 2007, p. 99). General systems theory has been seen as a source of ideas for developing the design of organizations, including determining proper work flows, control systems, planning mechanisms, and their interrelations. Carrying out the organization’s designated functions is a major issue for many organizations (Scott, 1998). The systems approach aids the observation of criminal justice in macro-terms and is also a useful perspective for potential developments because the systems theory is helpful in making systems more effective. Utilizing systems theory helps untangle management problems and makes organizations aware of their own dynamics (Kraska, 2004). In

addition to aiding the comprehension of current organizational systems, systems theory extends our understanding of a variety of political and social phenomena (Mesjasz, 1988).

The administrative attributes of police organizations allow us to understand organizations based on the systematic design of the entire agency, along with the units and tasks employed for the functioning of agency. Digital forensics practices need to be compatible with other parts of the police organization to carry out their purpose. Although digital forensics units in police agencies are among the smallest units in police agencies, their coupling with other units indicates the complexity of interactions and relations within the agency. The significant variation at each police agency and the alternative approaches used by different police agencies to deal with the same types of crimes lead this study to understand police organizations in light of contingency theory because it takes into account the complexity of dependencies in organizational settings.

### **Contingency of Organizations**

Contingency theory is a subdivision of systems theory (Scott, 2004; Bowditch & Buono, 2007). Contingency theory is one of the major theoretical views offering countless contributions to the history of organizational science (Donaldson, 2001; the term was coined by Lawrence & Lorsch in 1967 (Scott, 2004). Throughout the development of the theory, organizational scholars determined more features of organizations to be contingent on environment (Scott, 2004; Donaldson, 2001). Because police agencies are open systems, many attributes of police agencies, including their organizational control, strategies, and practices, rely on contingencies (Wilson, 2006). The contingencies of organizations may vary due to lack of sufficient resources or technological dependence. Several contingencies may influence decision making on the adoption of police practices such as crime analysis or digital forensic analysis.

In order to improve their effectiveness, organizations tend to adjust their organizational design according to their environment to deal with the complex matters (Lawrence & Lorsch, 1967). *Environment* includes the sum of physical and social factors (Duncan, 1972) where organizational design is dependent on environmental circumstances (Duncan, 1972; Scott, 2007). In order to respond to their environments, organizations establish a set of units and assign certain tasks to each in compliance with its specific environment. The major reason for this segmentation is that each management section in an organization has a limited capacity to observe and solve issues. Therefore, particular tasks are assigned to each unit in the organization so that the organization improves its specialized models and practices (Lawrence & Lorsch, 1986). For example, in order to deal with digital evidence, police agencies either assign specialized personnel or establish a unit contingent on the organizational environment of the police agency.

Organizational scholars suggest that organizational control influences the effectiveness of certain organizational processes (Tiessen & Waterhouse, 1983). One of the basic principles of contingency theory is that the control structure and course of “an organization must fit its context (characteristics of the organization's culture, environment, technology, size, or task), if it is to survive or be effective” (Drazin & Van de Ven, 1985, p. 515). Organizational processes can be perceived at the abstract level with the following concepts: “enacting, selecting, and/or retaining processes,” or at the more concrete level of “input, throughput, and output production flows and feedback control loops” (Scott, 2004, p. 384).

Organizational science commonly shows a relation between contingency factors and organizational control, and the relation between them is generally expected to be multivariate.



The relation is usually linear, which means the greater the value of contingency factors the greater the value of the structural variable. A change in contingencies usually results in a misfit of the old organizational control model. This problem is generally solved by adopting an improved and enhanced structure, which leads to an increase in the performance of the organization (Donaldson, 2001).

Police agencies that are not responding well to their external environment, such as the increasing amount and complexity of digital evidence in their community, are likely to be criticized by their environment, including citizens and other public-private agencies. Depending on the type of structural control and complexity, they may propose new solutions to deal with digital evidence. The environment and several factors that impact organizational control and the complexity of police agencies may eventually lead to the adoption of digital forensics practice.

Depending on the organizational environment, police departments may seek to find rational solutions to the staggering digital evidence problem. For example, highly complex organizations may tend to establish professional units to address digital evidence, while less complex departments may be willing to address the issue by either contracting out with another police department or dedicating personnel to solve the problem at the basic level. At this stage, contingency factors are discussed, specifically whether the options mentioned above would result in a fit or misfit to the organizational environment.

Adoption of digital forensics practice can also be explained as part of the organizational processes in police agencies, but the present study will not address those issues in the measurement model. Digital forensics processes include the inputting of digital evidence to the system by police agencies at a certain amount and degree of complexity that is exposed to

rigorous examination by police agencies. This inputting results in the output of several processes—that is, the presentation of evidence in court. In court, the feedbacks are usually based on criticism of the defendant’s lawyer, who challenges the admissibility of evidence. Essentially, all of these processes occur under the rubric of police organizational control, which is open to the influences of contingency factors under the open system perspective. For instance, the structural features of an organization, such as the strong formalization of an agency, can constrain the organization’s capacity—as, for example, when a police agency intends to adopt certain practices.

### **Institutional Theory**

Organizations, such as trade unions, governments, business corporations, and many others, are usually considered rational entities serving to obtain specified goals. It is customary to expect rational and systematic aptitudes from organizations because the mobilization of technical and managerial duties requires methodical approaches, which helps with incorporating specialized tasks. Nonetheless, an institution is an adaptive organism that is more likely to respond to the social needs and pressures of its environment than to responding rational factors (Selznick, 1984). Today, bureaucracy is still the dominant form of organizations, yet organizational change is less determined by efficiency. After a certain time, as organizations grow older, they primarily seek organizational legitimacy (DiMaggio & Powell, 1983).

Organizations are not resistant to their environments. They live in association with other organizations and unions. They move together with other organizations or unions to meet the institutional interests or legitimacy of themselves in an environment (Pfeffer & Salancik 2003).

Therefore, the sustainability of a program or practice in an organization may not be based on rational choices or cost-benefit analysis.

According to many scholars, police agencies are highly institutionalized organizations, as are other types of organizations. The mythology of crime influences community perceptions about crime as well as police agencies' approach to crime-related matters (Kappeler & Potter, 2004). Thus, in order to understand police agencies one should focus on their reaction to "powerful myths in their institutional environment" (Crank & Langworthy, 1992, p. 338). For instance, according to institutional theory, professionalism is one of the myths that bestows credibility on police agencies. In order to gain credibility, police agencies tend to specialize in order to comply with institutional myths (Langworthy, 1986).

Digital forensics practice is also a matter of professionalization; some police agencies tend to look more professional when it comes to dealing with digital evidence. Because police departments are located in a social environment where numerous institutional dynamics play a role in changing the agencies' organizational behavior, the variation in establishing digital forensics practice in police agencies should be scrutinized.

### **Institutional View**

The institutional approach claims that performance indicators such as efficiency, effectiveness, and production economies are inadequate to understand the "police practices and organizational controls" due to the effects of "environmental context" (Crank & Langworthy, 1992, p. 5). From an institutional perspective, environments' expectations of the organizations within them are not rational. Expectations are driven primarily by the interests or forces of powerful institutions. It is necessary to understand the forces to which organizations need to

respond in the environment. It is also important to determine how much an institution adjusts itself in society, where the power struggle of outsiders determines the degree of reaction by agencies.

According to Crank & Langworthy (1992), the environment significantly influences changes in organizational control and also police practice. When police departments conform their structure and activities to the institutional expectations of their environments, they are generally recognized as legitimate organizations by their environments. Van de Ven (1986, p. 593) explained innovations in organizations from an institutional perspective. He stated that as ideas are appreciated by powerful segments of the society and gain legitimacy, institutions change accordingly. Among a multitude of ideas, those that receive major support are institutionalized and implemented. These ideas become part of the organizational system and last as long as they adequately handle current issues of society and receive support from powerful segments of the populace (p. 593).

Strong institutional pressures and expectations from environment cause organizations to engage in interest-seeking behavior to help retain their legitimacy (Oliver, 1991). Nevertheless, the effects of institutional environments are usually myths rather than necessities of their work activities (Meyer & Rowan, 1977). Principally, values are of supreme importance in constructing institutional myths in organizational settings. Organizations have to determine key values in their respective organizational contexts that they can use in reforming social structures (Selznick, 1996).

In an institutional environment, social behavior is guided by schemas, rules, norms, and routines, all of which are subject to examination by institutional frameworks in regard to their

diffusion and adoption over space and time (Scott, 2004). Institutional theorists have claimed that urban police agencies usually comply with citizens' expectations and adopt specialized crime units "such as burglary, DUI, auto theft, fraud, gangs, assault, homicide, robbery, juveniles, vice, and narcotics" (Crank & Langworthy, 1992, p. 344).

When an organization realizes the importance of environmental power, it alters its comprehension about itself, which results in "recruitment, policy, and administrative organization at many levels" (Selznick, 1984, p. 7). When correspondence to the environment occurs, such as having a good client, an institution is likely to become steadier, receiving the necessary sustenance and experiencing better communication. Nonetheless, this dynamic causes organizations to be constrained by environmental factors, which leads organizations to become institutionalized (Selznick, 1984).

Isomorphism helps improve organizations' sustainability in society as organizations adopt the essentials of legitimacy (Zucker, 1987). DiMaggio and Powell (1983) stated that organizations that work in the same field of interest tend to be akin due to the effects of powerful forces. They describe three kinds of isomorphism that play important roles in shaping organizational control: coercive, mimetic, and normative. Coercive isomorphism occurs due to formal or informal pressures of other organizations on which the agency is contingent or the cultural expectations of the society that the agency addresses. Mimetic processes happen depending on uncertainty. Uncertainty about technology or environmental constraints may give organizations a reason to imitate other organizations that represent models of success in society. Normative pressures take place upon professionalism, which is based on an environment with

specific procedures, or a network of organizations that utilize exchange of information about the methods and conditions of their practices.

The fundamental values of policing are formed by institutional factors (Crank, 2003). Katz's (2001) view explained the organizational response of policing at the basic level. He claimed that when there is a perceived need to respond to a problem in the community, police organizations tend to adopt specialized practices to respond to the problems. Institutional reasons, as Katz (2001) stated, including the pressures of other significant groups, may bring strong support for the establishment of police practices.

### **Critique on the Institutional Theory**

Institutional theory has differed from other theories since its foundation on particular occasions. According to Scott (2008), institutional theory has followed a "monolithic view" to examine the control of organizations, focusing on social context with empirical observations (p.211). Scott also asserts that observations are mostly based on certain specifications where one hypothesis may not be valid in another condition. The character of institutional theory, in which ideas and symbols are considered to be important elements of organizational studies, are important arguments of critics against the theory.

While institutional theory has been criticized and discussed by organizational scholars, Scott (2008) claimed that many of the weaknesses of institutional theory, which were important problems two decades ago, had been transformed into more coherent structure. Institutional theory was criticized in terms of not being obvious and quantifiable, but rigorous researchers within the criminal justice field, such as John P. Crank, Jeremy M. Wilson and Edward R.

Maguire contributed to the manifestation of complexities in the theory through empirical research.

Another critique to the institutional theory was the lack of testing the interaction effect of varying attributes of organizations. According to Scott (2008) this problem has been largely confronted by identifying the minor fragments of organizational control. Each concept in the last few decades concerning institutional theory was disintegrated and their correlations with other variables were tested in many organizational studies. In another assessment, institutional theory was criticized as being highly “organization-centric” (Scott, 2008). To deal with this problem, Scott (2008) claims that the focus, which centers the “organization in an environment,” moved on to “the organization of the environment” (p. 216).

In another critique, institutions were viewed as stable and the process of institutionalization was overlooked. Recent studies are now highly focused on the process of institutionalization and the reasons that impact the spread of diffusion (Scott, 2008). Institutional theory is highly valued and it is still evolving, and pursuing the goal of explaining numerous contemporary and convoluted issues from varying angles.

This part of the study, utilizing institutional factors, only addresses subjective measures that consist of local police agencies’ environment. The internal functioning of police agencies is related to contingency factors usually perceived as part of the mechanical formation of the organization, such as task differentiation. It is necessary to know how environmental constraints may influence the adoption of digital forensics practice in police agencies. The specifics of environmental constraints are explained in the Theoretical Models and Data section, where each of the variables receives a thorough elucidation.

## **Innovation Theory**

Merriam-Webster's collegiate dictionary (2009) defined innovation as “the introduction of something new,” which could be a new idea, method, or device applied by an organization or individual. Damanpour (1991) described innovation as the “adoption of [an] internally generated or purchased device that is new to the adopting organization,” which includes different types of innovation concerning organizations and their operations (p. 556). Rogers (2003) stated that “an innovation is an idea, practice, or object that is considered new by a person or other unit of adoption” (p. 12). In order to consider an idea, practice, or object an innovation, it should be perceived as new by individuals. Society has used the words *innovation* and *technology* interchangeably. Although individuals could be observed to adopt innovations and technology, organizations are also considered the strongholds of adoption. Innovativeness indicates the relative timing of adopting new ideas prior to other units of adopters (Rogers, 2003). This study conceives digital forensics practice as an innovation in police departments. The use of computers and the Internet are technological developments which created new “models” of crime as well as attachments to traditional crime.

Innovation can be brought to an organization either by generation or adoption. Generation indicates that the organization produce a new product, service, program, or technology in order to utilize the outcomes for the sake of the organization or some other organization. Contrary to generation, adoption does not have to deal with idea generation, project definition, or design. Adoption necessitates processes such as awareness of innovation, attitude formation evaluation, and decision to adopt (Damanpour & Gopalakrishnan, 1998). The purpose of innovation adoption is to contribute a positive factor in improving the effectiveness of an



organization (Damanpour, 1991). The present study is not concerned with generating a new idea or application in police organizations; it rather is focused on the adoption of digital forensics practice.

### **Defining Innovation**

According to Pierce & Delbecq (1977) innovation is a highly convoluted concept and constitutes several properties. It is important to explain the diverse features of diffusion of innovation studies, as this study utilizes only specific parts of the diffusion of innovations theory. After a broad review of the literature, Wolfe (1994) distinguished three major research approaches in regard to the study of organizational innovation, each of which has a different focus, unit of analysis, and dependent variable: (a) diffusion of an innovation, (b) organizational innovativeness, and (c) the process of innovation (p. 407). These three approaches are also shown in Table 2.

King (2000) delineated innovation concerning policing “as something that is new and ‘state-of-the-art’ to the field of policing” (p. 309). First, diffusion of innovation occurs as “innovation is communicated through certain channels over time among the members of a social system” (Rogers, 2003, p. 11). Diffusion of innovation observes the layout of innovation by a populace of possible adopters. The purpose of a diffusion-of-innovation study is to “explain” or “predict” the degree and form of innovation for a specific amount of time and place. The unit of analysis is the innovation (idea or practice), and the focus of the research is to analyze the correspondence of “hypothesized” innovation models to actual diffusion rates and patterns (Wolfe, 1994, p. 407).

Second, organizational innovativeness research is focused on revealing why some organizations are more inclined to innovate than other organizations. Therefore, the unit of analysis, along with the unit of adoption, is organization. Organizational innovativeness is treated as the dependent variable, and the innovativeness research identifies the variance of the dependent variable (Wolfe, 1994, p. 407). Damanpour (1996) mentioned that organizational control theories of innovation seek to determine what structural variables are in effect in constructing innovation in organizations. Damanpour (1991) categorized the structural variables of organizations as organizational complexity and bureaucratic control. For example, while specialization, functional differentiation, and professionalism denote the former construct, formalization, centralization, and vertical differentiation are grouped under the latter construct.

Rogers (2003) stated that organizational innovativeness has focused on the characteristics of innovative organizations. Specifically, many researchers have worked on the relations between the structural characteristics of organizations and cluster of variables considered innovations. For example, organizational scholars found a positive relation between larger organizations and innovativeness. Openness, which refers to an organization's degree of relations with external factors, was found to have a positive relation with innovativeness. Contrarily, formalization, which denotes an organization's emphasis on the rules and procedures, has a negative relation with organizational innovativeness. Considering the second component of innovation studies, the present research focuses on diffusion of innovation, examining correlates of digital forensics practice as implemented by police agencies.

Third, Van de Ven (1986) defined the process of innovation broadly so that it can be applied to many innovation types. The process of innovation means the application of new ideas

performed by individuals in an institutional environment over time. Van de Ven claimed that the process of innovation is highly affected by “ideas, people, transactions, and context over time,” either positively or negatively (p. 591). Researchers tend primarily to understand the causes and effects of processes. As researchers focus on the innovation process as the unit of analysis, they examine the order of activities in implementing innovations (Downs, 1978). The innovation process has to contend with the choice of keeping the old practice or adopting a new alternative. The uncertainty of the practice and the newness of the idea is usually the biggest challenge for decision making (Rogers, 2003).

Although this study does not inquire about the process of innovation, it is useful to describe the processes in order to understand the innovation broadly. Zaltman (1973) bifurcated the innovation process into two major steps: initiation and implementation. Rogers (2003) explained initiation as agenda setting and matching. Agenda setting arises when there is a perceived problem about how the system acts in a given organization. Agenda setting includes two steps: recognizing the setbacks and utilizing innovativeness to deal with the organizational dilemmas. Matching takes place when the organization decides which innovation can overcome the specific problems of the organization. Decision makers in the organization must research the viability of the innovation project, considering what will happen when innovation is implemented.

Implementation consists of three major initiatives: redefining/restructuring, clarifying, and routinizing. Redefining/restructuring is needed because innovations are frequently faulty when first implemented. Hence, redefining and restructuring is required to make necessary changes based on the knowledge obtained after implementation. Clarifying the subject of an

innovation is necessary because the public or members of the organization need to understand the details through classification and description. Lack of clarification of the innovation may result in repercussions. Routinizing takes place when the innovation becomes indigenous to the organization and indicates that the process of innovation is finalized. Sustainability is an important aspect of routinizing because it guarantees the adoption and continuation of innovation.

Table 2: Major Approaches to Adoption of Innovation

<b>Focus</b>	<b>Measure</b>	<b>Unit of Analysis</b>
Explain or predict the degree and form of innovation.	Time and place	Innovation
Revealing why some organizations are more inclined to innovate than other organizations.	The relations between the structural characteristics of organizations and cluster of variables that is considered innovations.	Organizational innovativeness
The application of new ideas performed by individuals in an institutional environment over time.	The order of activities in performing implementation of innovations	Innovation process

## **Time**

This section of the study is not part of the measurement that explains adoption of innovation in digital forensics practice in local police agencies. However, it may be necessary to understand the time dimension of innovation adoption in order to have deeper information about innovation, which the present study utilized as the dependent variable of the study.

Organizational scholars have divided diffusion process into three components in terms of time: (a) the innovation-decision process, (b) the innovativeness of an individual or other unit of adoption, and (c) an innovation's rate of adoption in a system.

The innovation-decision process includes a long process that involves awareness of innovation through implementation and, later, either the rejection or the sustenance of innovation. Rogers (2003, pp. 20-21) suggested five steps to analyze the innovation process: (a) Knowledge is an understanding about the innovation where its occurrence and benefits are known to individual; (b) persuasion means a positive attitude toward innovation; (c) a decision is an operational activity where activities leads to the choice of either rejection or adoption; (d) implementation occurs as the innovation is processed by the individual; and lastly (e) confirmation includes either upholding the innovation to continue its implementation or rejecting the innovation due to disagreement about the innovation. Rejection of innovation after its implementation due to new alternative innovations or dissatisfaction is called discontinuance.

The second component of the time dimension regarding innovation study is innovativeness and adopter categories. Rogers (2003, p. 269) stated that in order to understand adopter categories, (a) the number of adopter categories, (b) the proportion of the members of a system to include in each category, and (c) the method, statistical or otherwise, of defining the adopter categories must be understood. Innovativeness means the comparative earliness of adopting innovations as compared to other affiliates in the same system. Rogers categorized adopters into five dimensions, where every category shares similarities: (a) innovators, (b) early

adopters, (c) early majority, (d) late majority, and (e) laggards.

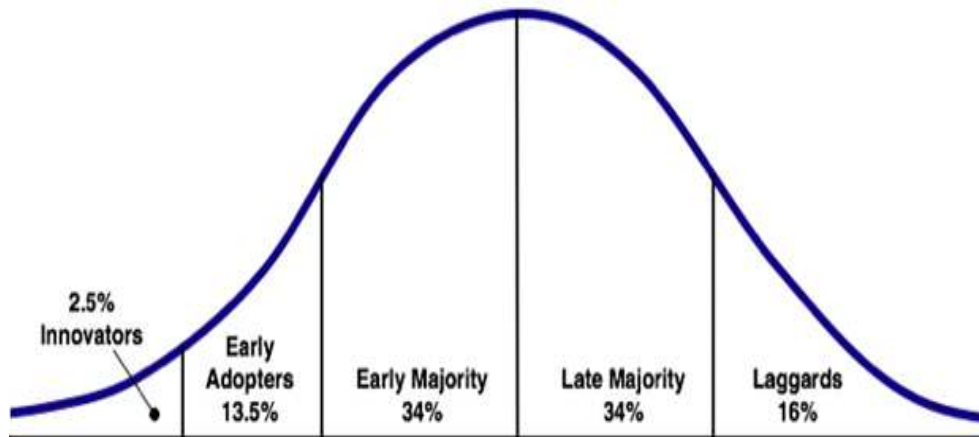


Figure 1: Adopter categorization on the basis of innovativeness

*Note:* This figure is adopted from Rogers' (2003) *Diffusion of Innovation*.

The third component of the diffusion time process is the rate of adoption, which means the comparative rapidity of adoption of innovation by individuals or organizations. The timeline of adoption of innovation resembles an S-shaped curve where the frequency of innovations is distributed (Rogers, 2003). After reaching the peak, the number of adopters steadily decreases (Rogers, 2003). As in many systems, innovations in police agencies have similar attributes: Only a few police departments adopt initially, and later on the speed of adoption increases (King, 2000). The same pattern could be observed concerning the adoption of digital forensics practice. However, as Weiss (1977) stated, the management practices of police organizations have important variances, and the adoption of technological and strategic innovations by police agencies comprises differing approaches (Weiss, 1997). Due to the unavailability of time and secondary data, the study will not specifically deal with the time dimension of the adoption of digital forensics practice.

## **Attributes of Innovations**

Innovations in organizations have different attributes. Innovations are not always correlated with the same organizational features, and the adoption of innovations varies in nature. It is important for practitioners to understand the differences in innovations in order to grasp adoption behavior in organizations (Damanpour, 1987). Rogers (2003) distinguished the attributes of innovation as (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. He claimed that “individuals’ perception of attributes of an innovation, not the attributes as classified objectively by experts or change agents, affects its rate of adoption” (Rogers, 2003, p. 223). Moreover, Rogers claimed that the biggest proportion of variance in the adoption of innovations, between 49% and 87%, is accounted for by attributes of innovation.

Because the perceived attributes of innovation have explained many different types of innovations in various studies, it is likely that it will also explain the adoption of digital forensic practice. Nonetheless, the focus of this study, as well as other limitations, prevented a focus on the perceived attributes of digital forensics practice.

## **Degree of Innovation: Radical and Incremental**

Degree of innovation is the dependent variable of the study, meaning the study focuses on the degree to which structural types of local police agencies have adopted digital forensics practice. As digital forensics practice is a relatively new innovation in policing, it is necessary to measure its adoption by police agencies.

Rogers (2003) stated that radical innovation necessitates a more arduous process than incremental innovations. Koberg, Detienne, & Heppard (2003) stated that radical innovations

purport major changes in organizations' "product/services, markets served, and technological breakthroughs" where supplying product or services is the important part of innovations (p. 23). According to Dewar & Dutton (1986), a greater degree of specialization increases the radical nature of the adoption of innovation. For instance, the greater the number of specialists who are concentrated on communicating with each other, the easier it is to comprehend technical knowledge.

Radical innovations are necessary for the efficient management of organizations in a competitive organizational environment (Koberg et al., 2003). Radical innovations require a high degree of knowledge to implement innovations. This knowledge demand, however, usually creates more uncertainty in organizations (Dewar & Dutton, 1986). Radical innovations also necessitate having enough resources to produce new processes and outcomes (Ettlie, Bridges & O'Keefe, 1984). Knowledge acquirement and the capacity to invest for innovations are important points for police agencies. In particular, the specializations of digital forensics units are highly dependent on the training of staff. Needless to say, training investment depends on the resource capacity of police agencies.

Incremental innovation has limited innovation capability and effect in organizations (Koberg, Detienne, & Heppard, 2003) and brings only a few changes to organizations compared to radical innovations (Dewar & Dutton, 1986). In contrast to radical innovations, incremental innovations occur in organizational environments in which technical expertise is not the case most of the time during the incremental innovation process (Rogers, 2003; Dewar & Dutton, 1986). Most of the time radical innovations are applied by large organizations, as they have the capability to employ specialized personnel (Rogers, 2003).



King (1998), in his study “Innovativeness in American Municipal Organizations,” claimed that innovations are categorized as radical and incremental in police organizations as well. King asserted that innovations such as laptops and other technical equipments are “item” innovations because they are not necessarily technological and are in essence incremental innovations. Therefore, he did not include item innovations as part of either radical or incremental innovations.

The present study utilized Dewar & Dutton`s (1986) test of radicalness of innovation. They used a 3-point scale based on the degree of new knowledge applied in 40 footwear manufacturers: (a) had no new knowledge contained in the machine or process; (b) represented an improvement over existing technology; or (c) represented a major technological advance (p. 1426). This study also measures the degree of radicalness with a specific scale, which will be specified in the Method section of this study.

### **Police Agency Types: Does Jurisdictional Difference Matter?**

The Census of State and Local law Enforcement Agencies (BJS, 2004) pointed out that America has a highly decentralized police system divided into jurisdictional territories that include local police agencies, sheriffs’ departments, state law enforcement agencies, and special jurisdiction agencies. Maguire, Snipes, Uchida, & Townsend (1997) critiqued the current jurisdictional system in the United States as baffling because many police agencies have to deal with overlapping tasks.

Although organizational scholars have analyzed many different types of business organizations, they have not given adequate importance to the divergence among police agencies. Since James Q. Wilson’s (1968) study “Varieties of Police Behavior,” most police

organizational studies focused on municipal police agencies, and the majority of police organizational studies have addressed the same issue—community policing. Yet, as Zhao, Lovric, & Robinson stated (2001), this focus has not made a significant change in the foundations of policing. Considering the focus on municipal police agencies, it is plausible to support Falcone & Wells’s (1995) claim that police departments have been treated as if they were identical, and yet numerous differences can be observed in regard to their administration and function. Inquiring as to the major disparities among different types of police agencies can bring greater understanding of policing and police organizational control.

The term *department* is used for agencies to indicate that they are part of an administrative body of government. Department is a term used for municipal police agencies. They are subject to the administrative regulations of the “mayor, commission, or city board, who oversee them and appoint their chief executive” (Falcone & Wells, 2005, p. 127). Sheriffs’ offices are known as offices as opposed to departments (only a few of them are called departments). As a part of the county government, sheriffs’ offices have different duties and principles that are most of the time discretely classified. They are highly independent police agencies, in contrast to municipal police agencies, because sheriff’s offices are not administrated by city executives or commissions. Moreover, sheriffs are most often elected officials who have to consider public opinion and reactions carefully. Sheriffs’ offices are openly political and seek popularity, while municipal police agencies are affected primarily by local politics (Falcone & Wells, 2005). In essence, in this political structure, the leadership of sheriffs may play a more significant role as compared to that of municipal police agencies because they are not constrained by mayors and administrative bodies. However, their decision to make changes in

the organization and implement certain practices is highly constrained or supported by the several local communities that form their jurisdiction.

G. Potter (personal communication, August 1, 2010) stated that although sheriff's offices are classified as offices, we cannot claim there are no exceptions. They are constitutional offices in 48 states while some are labeled departments, not offices. In fact, in Georgia, sheriffs are actually state employees because they are authorized by the state constitution, not simply the county constitution (Potter, 2010).

Because the variation in county sheriffs' offices has not been examined adequately, their organizational capacity is not known (Helms, 2007). Falcone & Wells (1995) argued that the form of policing at the county level has traditionally differed from that of municipal police agencies. They claim that sheriffs' departments are distinctive in terms of their organizational characteristics and community structure as compared to municipal police agencies.

As compared to sheriffs' offices, local police departments are responsible for law enforcement and have few other duties to serve in their local jurisdiction. Sheriffs' offices' responsibilities exceed law enforcement activities to a great extent. They serve and preserve the county court and also maintain the county jail and correctional facilities. In some jurisdictions they even collect taxes and fees. Sheriff's offices have the power to make civil arrests as they perform civil law practices. For example, they can arrest a person without a warrant if they see that a person is a threat to society (Falcone & Wells, 1995). In some areas, sheriffs' offices tend to have higher budgets, which increase their capacity to perform specialized practices. They are also inclined to help municipal police agencies in technical matters that require extensive resources and expertise. Hence, they play a centralized role, though in formal conversations this

reality is not openly discussed. In order to generalize these observations, empirical research is needed.

Due to lack of data and constraining factors in collecting data for the researcher, this study will examine only local police agencies' capacity to support the adoption of digital forensics practice, in which many factors come into play to establish the practice. The research on municipal policing is still important, as they constitute the majority of police jurisdictions. Adding county sheriffs' offices as another focus of the study could have helped in proposing the idea that the jurisdictional variation of police agency is correlated with several organizational features.

Utilizing the theoretical literature and considering the theories and practices of police agencies, the following questions are presented to explain the adoption of digital forensics practice by police agencies.

### **Research Questions**

Specifically, the study seeks answers to the following research questions:

1. What is the design/structure/environment of large local police agencies?
2. What is the relative influence of organizational and environmental factors on the degree of adoption of digital forensics practice by large local police agencies?
3. What is the relation between environmental constraint and structural complexity of organizations?

### **Summary**

The present chapter discussed theories from a general perspective and then moved to the relevant literature concerning police organizations. The organizational behavior of police

agencies cannot be explained from a single point of view or theory. Hence, a number of sociological theories have been applied to a number of situations in the criminal justice field. Although according to contingency theory there is no one best way to organize (Galbraith, 1973, p. 2), fitting organizational control with the environment has been a significant part of theoretical testing for local police agencies. Contingency theory offers an opportunity to discuss contingencies based on their appropriateness within the organizational environment (Langworthy, 1984). In contrast, institutional theory inquires about subjective measures of organizational behavior and their impact on the change of organizations. Rather than measuring manifest factors, institutional theorists are interested in the degree to which slanted views are more effective in changing organizations.

The adoption of innovation could be explained by both contingency and institutional factors. Varying features of the adoption of innovation could be the result of fits or misfits of police agencies' structural control; alternatively, they could be a direct consequence of local police agencies' attempts to preserve legitimacy in the institutional arena. Hence, until now organizational theories were reviewed to address the basic theoretical approaches for assessing adoption of innovation by police agencies. By integrating the three theoretical frameworks—contingency, institutional, and adoption of innovation—the variation in digital forensics practice is tested by organizational factors.

## CHAPTER III: THEORETICAL MODELS AND DATA

This section starts by formulating a theoretically informed framework and then discusses concepts related to the adoption of innovation. Next, each concept is described and the related variables are explained in terms of how organizational scholars have evaluated them in the literature and the things revealed by considering those concepts, as well as what could be expected from these constructs that may enhance explanations of the adoption of digital forensics practice.

### Formulation of a Theoretically Informed Framework

Formulation of a theoretically informed framework is necessary to indicate the principles of this study. Several researchers have identified major concepts of organizational studies. Wan's (2002) identification of health care service delivery systems is useful in guiding the present study. He specified three major components of service delivery system in health care services, as shown in the following figure.

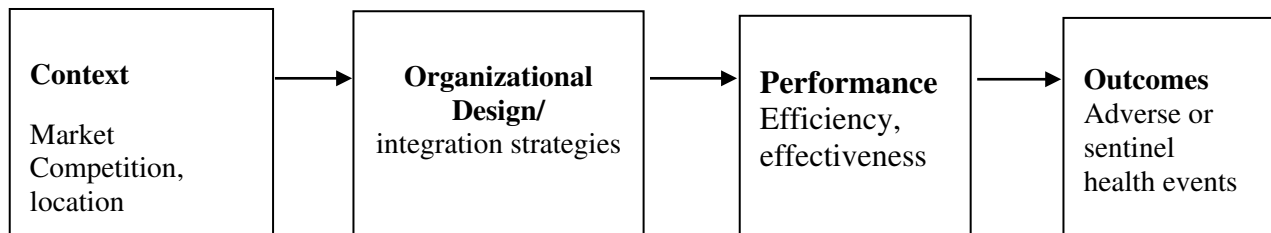


Figure 2: Conceptual Model for Health Care Service Delivery Systems.

Following an organizational research model, this study developed its conceptual model, specifying the structural relations among the study constructs as shown in Figure 3. This path diagram postulates the relations of environmental constraints, organizational context, and organizational control to the adoption of digital forensics practice (DFP). The study assumes that

environmental constraints and organizational factors (context and control) have a direct influence on the adoption of digital forensics practice.

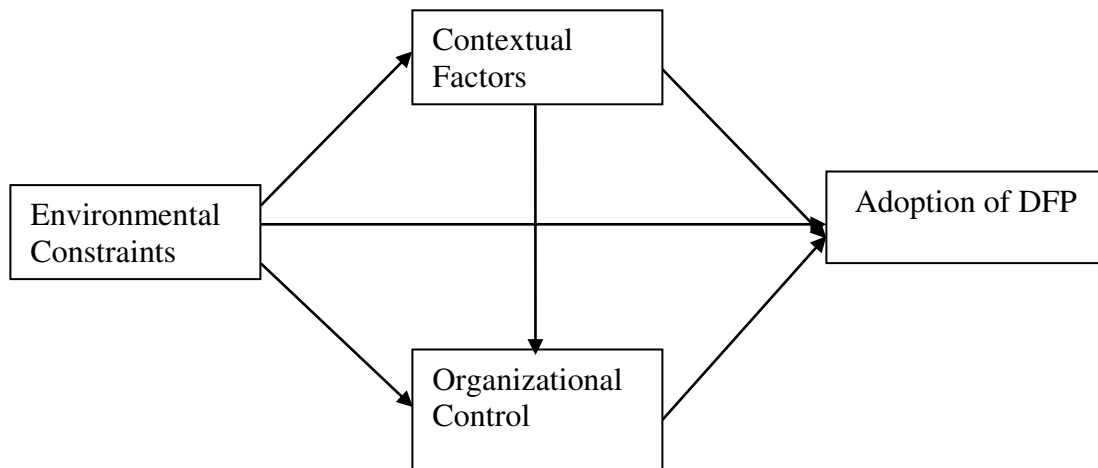


Figure 3: Path Diagram of the Hypothetical Model.

This section further explains the hypothetical model by unfolding how each construct is related to the adoption of digital forensics practice as shown in Figure 3 and offering descriptions to explicate factors that influence the variation in the adoption of digital forensics practice. Moreover, each concept is explained in the following section of the study.

### **Environment**

Many sociologists have speculated on organizations` relations with their environments. Scott & Davis (2007) claimed that organizations have been considered resistant to change. Organizational change is related to organizations` broader environment, such as population, economics, and politics, or to local entities such as the legal structure of the state, county, and municipality. Organizational change is also related to the dyadic environment of organizations, in which other organizations come into consideration. For example, the dyadic relation between

organizations occurs in terms of receiving inputs from contractors or outsourcing services from other organizations.

The study conceives environment as an entity with the capability to surround each individual sub-entity in a specific jurisdiction or legal system. In this study, environment's relation with the various attributes of police organizations and the adoption of innovation is examined as unidirectional where environment exerts effects. In order to give it special emphasis, the concept of environment should be dealt with separately rather than as one among other contextual variables of organizations. Many organizational studies have treated environment as a component of contextual factors. Nonetheless, Maguire (2003) stated that the contextual factors engender dispute regarding the factors' relative importance in shaping organizations. In order to address this problem, the present study treats environment separately from other contextual dynamics to curtail the haziness of contextual variables and clarify the relative importance of each environmental variable.

Organizations are affected by several factors, which makes it harder to predict which factors are more influential in changing the attributes and practices of organizations. Langworthy (1986) stated that it is a daunting task for organizational scholars to examine the relation between the environment and organizations due to the extensiveness of alternative premises. Scott (1998) noted how the complexity of this problem has been addressed by mentioning the fact that organizational scholars have distinguished between the institutional and technical environments. While the institutional environment consists of "symbolic, cultural factors affecting organizations" that are related to legitimacy, the technical environment comprises "materialist,



resource-based features” which are goal oriented and aid in the pursuit of goal achievement (Scott, 1998, p. 131).

### **Environmental Constraints**

Organizational scholars have meticulously tested the relation between several police practices—including community policing, gang units, and crime analysis—and the environment. These scholars include Wilson (1968), Langworthy (1984), Katz (2001), Maguire (2003), and Wilson (2006). However, the importance of environmental constraints on the adoption of digital forensics practice has not been scrutinized. This study deals with the environment as regards the constraining impact of the organizational environment in which the police agency is involved. Specifically, the study inquires into the impact of environment on the structural control and complexity of police organizations, as well as the adoption of digital forensics practice in police agencies. The study examines the impact of environmental capacity on organizations in light of institutional theory.

The United States comprises many powerful institutions (Selznick, 1957). From the viewpoint of an organization, the major influential factor for organizations is “other organizations” with which they have a relation (Scott & Davis, 2007, p. 221). Maguire (2003) claimed that environmental capacity indicates the ability of an organization to deal with the constraints levied by third-party organizations. Institutional environment, including third-party organizations, has the capability to exercise normative, mimetic, or coercive pressures on organizations. According to Pfeffer & Salancik (2003), environment evidently affects organizational practices. The institutional environment imposes pressures on organizations to conform them to norms and values that the environment contains. Moreover, as Thompson

(2003) stated, institutional pressures are tolerated by organizations because they are willing to receive support for their “existence” and “stability” in the future (p. 35).

In order to continue specialized practices’ existence and stability, police agencies have to sign off on important proposals. Decision making in police organizations is usually performed either by the individual power of the police agency or by external powers that either enable or limit agencies’ decision making. Police agencies consent to share their decision-making power due to the fact that powerful entities are willing to intervene or constrain the policies of police agencies. Moreover, in consenting to other organizations’ contributions to decisions, police agencies may be demonstrating their willingness to legitimize their actions by receiving support from their environment (Crank & Langworthy, 1992).

Duncan (1972) mentioned that in order to comprehend the relation between organization and environment empirically, identifying the components of environment is significant. Certain factors in the organizational environment may affect the adoption of police practices in specific ways. This study inquired into the constraining impact of institutional environment on the adoption of digital forensics practice in large local police agencies.

Various institutions and external relations may influence police agencies’ structural control and adoption of digital forensics practice, including unions and citizen (complaint) review boards, investigation of complaints outside of the police department, and regional location. These factors will be operationally addressed in the measurement section of the study; however, only citizen review panels and regional location will be delineated to discuss their potential effect on the adoption of digital forensics practice.

### **Citizen (Complaint) Review Boards**

Citizens, who are the living constituents of the community, have no direct involvement in police agencies' decision-making processes concerning issues related with law enforcement practices. In police agencies, policy is made by the police executive, who has discretion in several issues, such as the number of traffic tickets issued or the number of drunk-driving arrests in the city. Citizens' influence on police agencies usually appears in the form of complaints when they see a significant problem in the city. These complaints usually occur in broader terms, including complaints about specific crime problems (Wilson, 2006).

The complaints of citizens may address an increasing gang problem, robbery, or fraud in specific parts of the city. Moreover, complaints may involve fraudulent activities in cyberspace due to which citizens may experience substantial loss in their bank accounts and blame the police agency for not dealing with digital evidence properly. The presence of a complaint review board and its institutional influence may lead to a new structural arrangement in police agencies in various forms, including assigning a dedicated individual to deal with digital evidence or establishing a new unit in order to respond to citizens' complaints. Moreover, police agencies' sensitivity to citizen complaints indicates their degree of ability or willingness to comply with environmental situations such as a staggering crime problem.

### **Regional Location**

The United States consists of four regions: the Northeast, South, Midwest, and West. Blau and Scott (1962) stated that the geographical location of an organization can play a significant role in shaping the organization. According to many criminal justice scholars including Maguire (2003) and Wilson (2006), police agencies located in the western region of America are more likely to be innovative than those in other regions of America. Therefore, the

study will inquire into whether the location of a police agency shapes its complexity and adoption of innovation.

### **Contextual Factors**

Organizational scholars have identified several contextual variables as impacting organizations in many ways. Contextual variables could be sorted into three different dimensions: “the size of an organization, the age of an organization, and the technology that organization uses to produce its goods or services” (Maguire, 2003, p. 71). While this study delineated contextual variables, their relation with innovation adoption was conceptualized with police innovations, such as COP or other types of police innovations, due to lack of organizational research on digital forensics practice.

Contextual factors are the most important guides in forming police organizations. The importance of the characteristics of police agencies has been noted by many organizational scholars (Maguire, 2003). Organizational context determines the structure of police agencies due to its constraining influence (Child, 1972). This may in turn affect the adoption of specialized units (Wilson, 2006). The context in which police agencies are situated is also likely to affect the adoption of digital forensics practice. For example, the presence of a larger-size police agency may indicate that the police agency has enough capacity to spend its budget on hiring/assigning personnel for digital forensics practice. Contrary to this belief, based on the importance of technology, police agencies may prefer to utilize devices and software rather than recruit more officers. In addition, police agencies with a long history (age) and experience in investigations may choose to adopt more radical solutions to address their community problems.

## **Size**

Although Pugh et al. (1963) considered size a contextual variable, neo-Weberian structuralists have acknowledged size as a structural characteristic of organizations (Kimberly, 1976). Organizational size is considered one of the most significant indicators and attributes of the divergence in organizations' structure (Presthus, 1958; Child, 1973), although its relative importance has been perceived differently (Hall, Haas, & Johnson, 1967).

Size is also a good predictor of an organization's structure when measuring the contextual variables with multivariate analysis. The number of employees (counting part-time employees as half an employee each) and number of sites of an organization are considered to be indicators of the size of an organization. Because an organization is structured mainly by individuals assigned to perform certain functions, the number of people employed in the organization should be considered a significant component of the organizational control (Child, 1973).

Langworthy (1986) stated that, according to many theorists, the size of police organization influences particular characteristics of organizational control. Blau (1970) analyzed data about the structure of multiple government agencies in the United States and concluded that "increasing size generates structural differentiation in organization along various dimensions [spatial, occupational, hierarchical, and functional] at decelerating rates" (p. 204). Blau also stated that a positive correlation exists between size and number of offices, number of occupational positions, and number of hierarchical levels.

The total number of workers in an organization may not provide adequate data to measure the size of an organization. Part-time contingent workers may be as important as full-

time employees within the company. Seasonal workers and their support to the organization may also have a major effect. The relative importance of the number of employees according to the norms created by similar types of organizations is also an important contributor in deciding whether an organization is large, medium, or small (Bowditch & Buono, 2005). Police agencies include part-time and full-time personnel, similarly to other public agencies. The personnel of police agencies include sworn and nonsworn officers. Sworn police officers have the greatest importance, as they are directly involved with enforcing the law and managing the police departments.

Langworthy (1986) stated that, according to many theorists, the size of the police organization influences particular characteristics of organizational control (structure). In contrast to many scholars, Wilson (2006) found no significant relation between the size and structural complexity (spatial, occupational, and hierarchical differentiation) of police agencies and their administrative weight and formalization. Maguire (2003) found the size of the police agencies significant in terms of influencing structural complexity in organizations. He stated that larger police agencies necessitate a more complex structure. Maguire found no significant relation between size and structural control factors, which include formalization, centralization, and administrative weight. King (1998) found a positive relation between structural complexity and size, while he only found a significant relation between organizational size and formalization, which is a part of structural control.

Langworthy (1986) found a negative relation between organizational size and spatial differentiation, which means that larger police agency size indicates increased spatial differentiation for the police agency. Concerning hierarchical differentiation, Langworthy found

a positive relation with the agency size. For example, the presence of more officers suggests the presence of more hierarchical differentiation. Langworthy claimed that a negative relation exists between organizational size and occupational differentiation, while a positive direct relation exists between agency size and functional differentiation. In his analysis, he also found a direct relation between administrative overhead and organizational size.

Zhao (1996), Maguire (1997), and King (2000) found a positive relation between size and COP implementation. Wilson (2006) found no relation between structural control and COP implementation. These previous studies' findings concerning the relation of size with other variables vary; nevertheless, size as a concept is highly important and encompassing in nature. Maguire (2003) stated that the measurement of size may not be perfect for each study. More research needs to be done on the subject. Based on the variation in statistical results, the present study seeks to clarify the relation between the size of police agencies and organizational complexity, and the adoption of digital forensics practice.

### **Organizational Age**

It is reasonable to think that more experienced and older organizations are more likely to give well-versed decisions that in turn lead to better understanding of the results of their actions. Therefore, more experience may give police agencies the ability to design their agencies' organizational control more effectively (Wilson, 2006). The literature about organizational age is relatively weak considering the number of studies in the literature. However, a number of organizational scholars have found a relation between organizational age and organizational control (Maguire, 2003).

Aiken & Alford (1970) found a negative relation between organizational age and innovation due to organizations' tendency to become more bureaucratic and less open to innovation as they get older. King (1998) found a positive relation between COP programmatic implementation and age, yet he claimed their relation was not significant. Wilson (2006) found that the age of police agency affects COP implementation.

Wilson (2006) found no relation between organizational age and both the structural complexity and structural control of organizations. Maguire (2003) found a positive influence of organizational age on “vertical differentiation, controlling for organizational size and other contextual variables” (p. 213). King (1998) also found a positive influence of organization age on vertical differentiation.

The age of a police agency and its experience in dealing with a variety of crimes and forensics issues may help them develop ideas or knowledge about new innovations more easily than recently established or less experienced police agencies. However, it is also likely that recently established police agencies may adapt themselves to technological advances more easily than older police agencies.

### **Technology (Task Scope) or Perceived Technological Sophistication**

According to Perrow (1967), one of the defining characteristics of organizations is technology. In general terms, *technology* suggests the performance of actions by a person with or without the help of tools to make particular changes in an object. Pugh et al. (1960) defined technology as the chain of physical methods used for the progress of the organization in which technology helps in providing services by the pattern of operations or the equipments used. Perrow (1967) stated that technology is often conceptualized intact instead of being considered



only through specific practices or subcomponents. Bowditch & Buono (2005) mentioned that many people consider technology as taking the form of high-tech devices such as computer networks, fiber optics, robots, and so forth. Indeed, technology includes various activities that organizations utilize to produce their products or services. Bowditch & Buono (2005) affirmed that these activities include everything from “micro-computers, to hand-processing different forms, to the pedagogical technologies (lecture, case method, experiential exercise) chosen by the instructor” (p. 277). As Bowditch & Buono (2005) asserted, large and complex organizations in particular make use of diverse technologies for varying functional areas with various magnitudes of complexity.

Perrow (1967) noted that the two most important aspects of technology in terms of the structure of organizations are the number of exceptional cases to come out during the work and the character of the search process performed by the individual when the exceptions occur. Perrow distinguished the search into two phases. The first phase, a matter of nonroutine process, can be conducted on a rational and analytical basis by the person and usually yields the result that the search process does not have any existing program that aids the search process. The second form of search process has to overcome imprecise and nonanalyzable problems. In this case, the solution is built upon sense or estimation, and formal search is cast away.

Hickson, Pugh & Pheysey’s (1969) three-stage description of technology contributes to the understanding of different approaches to technology by scholars: operations technology, materials technology, and knowledge technology. Pugh et al. (1963) described operations technology as "the techniques that [an organization] uses in its workflow activities" (p. 310). Operations technology can be characterized as “sets of man-machine activities which together

produce a desired good or service" (Hickson et al., 1980, p. 209). Thomson and Bates (1957) described materials technology very similarly to the way Perrow did, saying that "intensive technology"—that is, the means of production—is dependent on the object or material itself (as cited in Hickson, Pugh, & Pheysey, 1969, p. 380). Perrow described knowledge technology as the quantity of "exceptional cases encountered in the work" and the extent of rational analysis accomplished (Perrow, 1967, p. 195). Accordingly, the overall meaning of the knowledge technology reflects the characteristics of knowledge managed in the workflow (Thompson, 1967).

Maguire (2003) found no significant relation between task and structural control variables. Wilson (2006) claimed that a statistically significant association existed between task scope and occupational differentiation, yet he did not claim any significant relation between task scope and spatial differentiation concerning the number of stations. Wilson also did not find a significant relation between administrative weight and task while he found positive relation between task scope and formalization.

The tasks of organizations are interdependent (Lawrence & Lorsch, 1986) and contingency theory suggests that "task in organizations varies in accordance with community needs and expectations" (Langworthy, 1986, p. 28). The organizational adoption is best accomplished when the needs of the environment are harmonically contingent on the internal features of the organization (Scott, 2007). As several scholars touched on the importance of task in changing organizations, for this study it is necessary to assert whether task is significant in the adoption of digital forensics practice in police agencies and organizational control variables.

### **Organizational Control (Structure)**

The organizational control of the police agency may have a significant impact on the adoption of digital forensics practice. For example, while some police agencies with higher complexity may pursue advanced perspectives, others may be committed to straightforward solutions in addressing digital forensics practice. In contrast, police agencies that give special credence to structural control and coordination may not be open to new developments.

Numerous studies have been conducted to examine organizational control within the last century (Bodwitch, Buono, & Stewart, 2007). However, police agencies have received little attention from organizational scholars. Indeed, the research on police agencies is far more focused on the “paramilitary nature of the police, the flaws of the police rank structure, and the people” (Maguire, 2003, p. 2).

The criminal justice field has gained a large part of its knowledge by developing the applications of empirical testing (Bernard & Engel, 2001). Nonetheless, in addition to a large amount of unexplained variance in studies of the criminal justice system (Hagan, 1989), the variance of organizational control in police agencies has not been adequately examined. Among 150 empirical studies of police behavior, only 10 have addressed police organizational control, and only a few reformers have responded to concerns and demands regarding changing organizational control in the U.S. (Maguire, 2003).

Pugh, Hickson, and Hinings (1969) stated that two major problems exist in empirical organizational studies. First, many of them presume that all organizational classifications, such as context, purposes, structure, and functioning, are meticulously interconnected. Moreover, organizational studies deduce that the interconnectedness suggests “one-to-one interdependence”

among the set of organizational variables. The second problem is usually related to “piori” classifications in which “the only concession to empirical complexities [is] the admission that they are in some sense pure, ideal, or archetypal” (Pugh et al., 1969, p. 115). Eventually, the inadequacy of classification has led organizational scholars to generate their own classifications (Pugh et al., 1969).

Child (1972) identified organizational control as “the formal allocation of work roles and administrative mechanisms to control and integrate work activities, including those which cross formal organizational boundaries” (p. 116). Concerning police organizations, Langworthy (1986) defined organizational control as a “framework on which a police organization arranges its resources to conduct its activities” (p. 17). Organizational control has two major features: division of labor and coordination and control of work (Scott, 1998, p. 227). Division of labor has been conceived as complexity factors that differentiate organizational control. Blau (1970) claimed that complexity factors, including spatial, occupational, hierarchical and functional differentiation,<sup>3</sup> constitute the crux of organizational control. Maguire (2003) delineated the second main portion of organizational control as the coordination and control mechanism by which organizations regulate its labor and laborers. Structural coordination and control consist of centralization, formalization, and administrative weight.

Pugh (1969) stated that the organizational control functions within the organizational context—that is, organizational factors—account for the variation in organizational controls. Langworthy (1986) claimed that organizational scholars might be able to contribute to the improvement of police organizations by considering the variation in police agencies and

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<sup>3</sup> Blau (1970) defined differentiation as “the number of structural components that are formally distinguished in terms of any one criterion” (p. 204).

evaluating alternative models of proper police organizations analytically and determinedly. Moreover, as Langworthy (1986, p. 2) suggested, increasing knowledge about police organizational control may prevent unnecessary solutions, usually proposed in the form of “change the men” and “change the organization.”

Two major studies have inspired organizational scholars to examine organizational control of police agencies empirically. First, James Q. Wilson’s study “Varieties of Police Behavior” was considered to be “the only empirically derived theory of police organization” (Langworthy, 1986, p. 32). Wilson established a typology of police behavior using organizational theory to explain the variety of police behavior in eight different communities. He examined the relation between organizational style and political culture and contended that arrest behavior is related to organizational style, while professionalism was contingent on political culture. Nonetheless, his study did not have a direct focus on organizational control (Langworthy, 1986).

Langworthy’s (1983) “The Formal Structure of Municipal Police Organizations” was one of the first studies to examine organizational control. While Langworthy (1983) and Maguire (2003) examined and treated organizational control as a dependent variable, Wilson (2006) treated organizational control as an independent variable to test its relationship with community-oriented policing implementation. The present study also treats organizational control as an independent variable, which the study measures in terms of its impact on adoption of innovation.

### **Structural Complexity**

The formal structure of the organizations, including the allocations of responsibilities to units, is an important element of organizational design (Goold & Campbell, 2002). Large-scale

operations in organizations create difficulties in processing the workload; therefore, organizations partition responsibilities in various ways to facilitate the work of any operating employee, manager, and subunit in the organization. Many times the labor is categorized depending on complexity to make the job easy for unskilled workers and to provide more training and experience for the ones who are skilled and perform well. Responsibilities may be separated into subdivisions depending on the functions of divisions in order to make each unit of an organization more specialized. Furthermore, local branches may be established in various parts of the served areas so that each local branch makes use of specialization (Blau, 1970).

The structural complexity of organizations occurs in terms of spatial, occupational, and hierarchical differentiation. Differentiation in organizations increases the complexity of organizational structure (Blau, 1970). In essence, as police agencies' main focus is to address their community, they claim to differentiate their structure accordingly.

### **Spatial Differentiation**

Blau (1970) claimed that increasing the size of organizations leads to increases in the local branches of organizations' spatial differentiation. Maguire (2003) contended that size explains nearly the entirety of the spatial differentiation of organizations. Environmental dispersion and environmental instability also explain spatial differentiation in police agencies. Environmental dispersion explains spatial differentiation because larger jurisdictions necessitate having more local branches distributed throughout the jurisdiction. This increase in local branches leads to less centralization and reduces the effect on local branches of police agencies by the agency's headquarters.

Maguire (2003) found that spatial differentiation has a positive relation with organizational size, environmental dispersion, and environmental instability. Wilson (2006) did not find any significant relation between formalization and administrative weight. Maguire (2003) and Wilson (2006) claimed that complexity increases as spatial differentiation increases.

In this study, I expect to find a positive relation between spatial differentiation and the adoption of innovation. While I expect that spatial differentiation will be negatively correlated with administrative weight, it should be positively related with the number of staff, formalization, tasks, other complexity factors, and environmental constraint variables.

### **Occupational Differentiation**

Blau (1970) stated that occupational differentiation is measured by counting the number of job titles. Langworthy (1986) stated that occupational differentiation denotes reliance on specialization in terms of the training and skill enhancement of personnel.

According to Guyot (1979), in place of sworn police officers civilians are sometimes hired to comply with the needs of police organizations. Guyot (1979) suggested that “the very decision to hire civilians shows that the rank system lacked the flexibility to provide personnel with the desired skills at a reasonable salary cost” (p. 277). Especially in the digital forensics field, training a sworn police officer is quite expensive. Police agencies may prefer to recruit civilians who are already trained in the field.

Wilson (2006) found no relation between occupational differentiation and formalization, yet he found a positive relation between occupational differentiation and administrative weight. Maguire (2003) did not measure occupational differentiation. Langworthy (1983) found a

positive relation between standardization and occupational differentiation. He also claimed that a significant relation exists between occupational differentiation and police practices.

The present study considered the ratio of civilian personnel to all personnel as occupational differentiation. I expected to find a positive relation between occupational differentiation and the adoption of digital forensics practice. Hiring more civilian personnel might indicate a tendency to address professional issues, such as digital forensics practice or traditional forensics practices, with civilian personnel. I expected to find a positive relation between occupational differentiation and formalization. I also presumed that a higher degree of occupational differentiation indicated higher administrative weight. Because civilian personnel are usually employed for issues that do not require the use of force, they might be assigned more frequently to administrative duties. This tendency would in turn increase the relative size of occupational differentiation in police agencies. I expected that spatial differentiation would be positively related with occupational differentiation, while hierarchical differentiation could be negatively associated with occupational differentiation.

### **Hierarchical Differentiation**

Hierarchy has been considered one of the significant determinants of the way policing is done and the way authority is determined for individual positions in police agencies. Hierarchy denotes the level of administrative position within the police agency, yet exceptions may occur in different agencies at different levels. Guyot (1979) mentioned that the hierarchical formation of police agencies negatively influences police in dealing with environment and community problems.



Maguire (2003, p. 136) claimed that even though higher rank provides better extolment and wage, it does not necessarily denote higher authority. Maguire noted three different rank categories that in fact do not represent different levels of segmentations. The classification of police officers' ranks usually includes four different levels: I, II, II, and IV. Nonetheless, these levels of ranks are not distinguishable in terms of the resonance of the command level. Secondly, detectives have no noticeable supremacy over police officers. Both detectives and police officers are supervised by the sergeant and are supposed to perform similar tasks. Lastly, "corporal" rank, which is used to indicate a master police officer, is similar to the rank of a "regular" police officer in terms of authority, except for a few circumstances. To sum up, this study considered Maguire's classification and used the data that was collected by Maguire (2003).

Wilson (2006) did not find any significant relation between rank and COP implementation. He did, however, find a positive relation between hierarchy, formalization, and administrative weight. For example, a higher number of rank order in police agencies is associated with a higher number of formal rules. Langworthy (1983) found a positive relation between hierarchical differentiation, agency size, and standardization.

I expected to find an inverse relation between hierarchy and degree of adoption of innovation in local police agencies. I presumed that higher number of ranks would diminish the tendency to adopt digital forensics practice. The study was expected to find a positive relation between hierarchy and formalization, size, administrative weight, and centralization. I was also presuming I would find a negative relation between hierarchical differentiation and factors of environmental constraint.

## **Structural Control and Coordination**

Structural control is a mechanism that aids in the administration and coordination of differentiation in organizations (Wilson, 2006). Coordination is believed to be one of the most basic necessities of organizations (Van de Ven, Delbecq, & Koenig, Jr., 1976). Coordination denotes “integrating or linking together different parts of an organization to accomplish a collective set of tasks” (Van de Ven et al., 1976, p. 322). The primary ways to control police organizations are administration, formalization, and centralization (Maguire, 2003).

## **Administrative Weight**

Organizations are framed with authority structures in which the skeleton of the organization consists of upper-level personnel who constitute the administration and lower-level staff who comprise the underlings (Pugh et al., 1963). Administrative intensity, overhead, and weight have been used on several occasions by organizational scholars. Administrative weight is considered to be the proportion of an organization's administrative component relative to all the members in an organization (Langworthy, 1986; Maguire, 2003). While subordinates perform the production and are directly involved with the core of the work, managerial staff are indirectly involved with the production and perform supportive functions for the underlings (Maguire, 2003).

Blau (1970) assessed the administrative weight (overhead) of organizations as the number of administrative staff and managers relative to its all members. Blau found a negative relation between agency size and administrative overhead. Maguire (2003) and Wilson (2006) used both the administrative and technical support personnel at the administrative level to measure the relative size of administrative staff relative to all of organization's members.

Maguire (2003, p. 201) used LEMAS-1993 to measure administrative weight; LEMAS-1993 asked municipal police agencies to list the total number of full-time employees working in six different fields: administration, field operations, technical support, jail operations, court operations, and other. LEMAS-1999, which this study utilized to measure administrative weight, includes the chief executive and the staff of the executive personnel and all subordinates who work for the administration, comprising finance, human resource, and internal affairs staff. The technical personnel include dispatchers, records clerks, data processors, and other personnel providing support services (LEMAS, 1999). Wilson (2006) calculated the administrative weight as Blau (1970) and Maguire (2003) did.

Wilson (2006) found that the administrative weight was associated with region, occupational differentiation, ranks, functional units, and formalization. Wilson's findings did not support a significant relation between COP implementation and administrative weight. Maguire (2003) did not find any significant impact of administrative weight on any of the variables included in his structural model of local police organization.

Administrative weight might significantly influence the adoption of digital forensics practice. Too much reliance on administration may increase the level of formalization at the police agency, which may lead to the development of numerous barriers between the administration and lower-level officers who work as the primary dispensers of law enforcement for their community. I also expected to see more centralization for those police agencies with a relatively higher number of administrative personnel. Moreover, I hypothesized that the relative number of administrative personnel might impact structural complexity at the police agency. A higher number of administrative personnel may be correlated with a higher number of divisions

and units in the police agency, which may increase the degree of complexity in the police agency.

### **Centralization**

Pugh (1969) stated that centralization is related to the locus of the decision making in organizations, which leads to either immediate or successive employee compliance. Maguire (2003) identified centralization as “the degree to which the decision-making capacity within an organization is concentrated in a single individual or small select group” (p. 17). The number of decisions made in cooperation with others determines the degree of centralization; therefore, the lower the participation, the higher the centralization (Hage, 1965). While centralization may increase an organization’s capacity for interior control of the organization, it may reduce an organization’s capacity to provide decisions quickly. Centralization also lowers the chance of receiving more information from ordinary employees (Maguire, 2003).

Maguire (2003) established a survey to measure the centralization at each police agency he studied. His scale of centralization indicates 0 for low centralization and 80 for high centralization. Lower values indicate lower centralization and more participation according to his index. Wilson (2006) claimed that no relation exists between COP implementation and centralization as there was no relation between administrative weight and centralization. Wilson (2006) did not find any signification association of centralization with any other variable. Maguire (2003) found that contextual variables are associated with approximately 14% of the variation in centralization, which nevertheless indicates a minor relation with any of the contextual variables. He also did not find any significant impact of structural complexity on centralization.

Digital forensics is practiced at the lower level and by an individual(s) known for her expertise in the field. In highly centralized organizations, a deputy or sergeant may not be able to play a role in making strategic decisions concerning digital forensics practice, as the decision making is not spread toward lower-level officers. This may eventually constrain information sharing in the organization, which in turn leads to uninformed and uneducated decision making. Maguire (2003) stated that centralization makes organizations very rigid, preventing police officers and practitioners from applying well-informed practices.

In this study, it is expected that a negative relation would emerge between centralization and the adoption of innovation. The study expects to find a positive relation between centralization and formalization and administrative weight, while an inverse relation was expected to emerge between structural complexity, environmental constraints, and centralization. For example, I expect to see spatial differentiation increase as centralization decreased because spatial differentiation would lead to sharing administrative duties and privileges of management in police agencies.

### **Formalization**

Organizations define rules and procedures to bring the system into the desired level of formalization (Child, 1972). Formalization is defined as the degree of written and filed communications, procedures, and rules in an organization (Pugh et al., 1968; Hage, 1965). Formalization is also called standardization, by which jobs are codified and the span of variation is approved of concerning given tasks (Hage, 1965). Formalization is usually provided by storytelling or official promulgation so that it is understood and remembered by a large number of people (Walsh & Dewar, 1987). Some organizations are highly formalized, with many rules,

forms, and standards permitting only a few exceptions; yet many other organizations are exceedingly informal, relying on simple control processes (Maguire, 2003). Many times, the fraction of codified jobs and the exceptions within the rules determine the degree of formalization in organizations (Aiken & Hage, 1966).

While a lot of room still exists for making explicit contributions in a pragmatic sense, many scholars emphasize the importance of formalization in organizations. The degree of formalization in organizations depends plainly on formulated rules and prearranged roles that are independent of the personal attributes of and relationships between persons. Standardization and regulations help predict an organization's behavior (Scott, 1998). Formalization also makes the structure of relationships more overt and discernible among a set of roles and principles that dominate behavior in the organization (Scott, 1998).

While formalization may have very positive effects, it also presents problems, especially for units based on information technology. Digital forensics units have many day-to-day activities that change depending on technological innovations, which are ongoing. On the other hand, formalization creates a body of rules that are hard to adapt and implement for police agencies' computer forensics units. Hence, it is important to understand the formalization of police agencies and its impact on digital forensics practice.

According to organizational scholars, the major determinant of formalization is complexity. Complex organizations have administrative drawbacks in terms of coordination and control of processes. Increased formalization through the description of controls and regulatory rules, practices, and systems may help mitigate problems in complex organizations (Child, 1973).

King (2000) found a positive relation between COP implementation and formalization. Wilson (2006) found a positive relation between formalization and COP implementation, though his expectation was the opposite. Wilson did not find any significant relation with formalization and other structural control and complexity variables. Maguire (2003) came up with the same conclusion that none of the indicators predicted formalization and vice versa.

King (2000) mentions that less formalization gives more flexibility to employees when they attempt to establish innovations, while Rogers (2003) claims that adoption of innovations could become long-established when they are fortified with strong rules. Based on King's arguments, although his findings and Wilson's (2006) findings were the opposite of what they suggested, I expected to find a negative relation between formalization and the adoption of digital forensics practice. I assumed that more formalization would reduce interest in the adoption of innovations, including the adoption of digital forensics practice. Moreover, formalization may be correlated with more structural complexity and fewer environmental constraints. For instance, more formal organizations may not be open to having significant relationships with unions that entail partnership with their environment.

### **Major Studies of Organizational Control**

Environment, organizational characteristics, and organizational control are important elements of organizational research. Structural studies of police organizations have been the proxy for examining these concrete features of organizations together. Nonetheless, only a few studies have meticulously and broadly examined the organizational control of police agencies. In 1986, Robert H. Langworthy published his research on the factors impacting organizational control in large municipal police agencies, entitling it "*The Structure of Police Organizations.*"

Structural organizational theory is elaborately applied to police agencies in other studies such as Edward R. Maguire's "*Organizational Control in American Police Agencies: Context, Complexity, and Control*" in 2003 and Jeremy M. Wilson's "*Community Policing in America*" in 2006.

Two comprehensive studies contributed to the progression of the study of organizational control concerning police organizations. First, Maguire (2003) made a large contribution in filling the gaps of organizational control studies. He divided organizational control into structural complexity, structural coordination, and control mechanism. While contextual factors mainly include organizational size, task scope, and environmental capacity, Maguire addressed structural coordination and control mechanism in terms of differentiation and administration. Maguire stressed that organizational context has a direct impact on organizational complexity and structural control. Second, Jeremy M. Wilson (2006) focused on organizational control to explain the variation in the implementation of community-oriented policing. He concentrated on finding the determinants of community-oriented policing and purported to explicate the causal association between the implementation of community-oriented policing and organizational control. He utilized both institutional and contingency theories to explain this causal relation as commonly applied by most organizational scholars.

Table 3 denotes the independent variables used in organizational studies that explain police organizational control. Most of these variables shown on Table 3 are explained in this study within the appropriate context. The last three of the scholars, King (1999), Maguire (2003) and Wilson (2006) have contributed the most to the organizational research community as compared to many other scholars.



Table 3: Independent Variables Used in Studies Explaining Police Organizational Control

<b>Study</b>	<b>Variable</b>	<b>Measure</b>	<b>Relevant Findings</b>
Ostrom, Parks, and Whitaker (1978)	Size	Number of sworn officers	Smaller local police agencies assign less number of police officers to administrative duties
Langworthy (1986)	Size	Number of employees (derived size is strongly related to spatial differentiation, weakly from Blau)	Size is significantly associated with spatial differentiation, while it is weakly related to other organizational structural variables.
	Technology	One minus the number of personnel assigned to patrol (derived from Perrow)	Technology is consecutively associated with functional and occupational differentiation. It is unconvincingly related with other structural variables.
	Environment	1) Population Size  2) Complexity of inputs—uses population heterogeneity and mobility (derived from Perrow)	Population size and organizational size are associated significantly. Civilianization was the only factor that was related to population complexity.
Slovak (1986)	Size	Number of full-time police employees	Size did not have influence on police organization's differentiation, and administrative intensity has negative relation with size.

<b>Study</b>	<b>Variable</b>	<b>Measure</b>	<b>Relevant Findings</b>
Crank (1989)	Organizational Size	Changes in the number of employees	Civilianization is most influential when agencies' size is in decline
	Geographic Status	Urbanization (rural-intermediate-urban)	Considering civilianization rural police agencies were as innovative as urban police agencies.
	Size	Number of full-time employees	Height, concentration, and supervisory ratio were related to the change in size
Crank & Wells (1991)	Urbanism	Percentage of the county that is classified as urban	Controlling for size, urbanism does not influence organizational control
King (1999)	Age	Length of time since organization was founded	Controlling for size, older organizations employ fewer civilians and are more hierarchically differentiated.
	Size		Found positive correlation between size and organizational complexity and he also found positive relation between size and formalization.
Maguire (2003)	Age	When a police department first instituted uniformed, paid, full-time 24-hour police services within a single organization	Age positively influences organizations concerning vertical differentiation, controlling for organizational size and other contextual variables.

<b>Study</b>	<b>Variable</b>	<b>Measure</b>	<b>Relevant Findings</b>
	Task Scope	The primary functions performed by the police department	No significant relation between task and structural control variables
	Environmental Capacity	Whether the police agency is associated with third party organizations	Environmental capacity has a significant impact on organizational control
	Environmental Complexity	Sum total of the ways the residents of a community differ from one another	Environmental complexity has no significant association with organizational control
	Size	Number of personnel.	No significant relation between size and structural complexity (spatial, occupational and hierarchical differentiation) of police agencies and also administrative weight and formalization
Wilson (2006)	Technology	Number of different tasks performed by the agency	Significant association between task scope and occupational differentiation, yet no significant relation between task scope and spatial differentiation concerning the number of satiations.  No influence on administrative weight.  Significant influence on formalization.

<b>Study</b>	<b>Variable</b>	<b>Measure</b>	<b>Relevant Findings</b>
	Population Mobility	Proportion of residents at least five years old in the 1990 Census who lived at a different address in 1985	Population mobility positively influences COP implementation.  No significant relation between population mobility, and number of stations and occupational differentiation.
	Environmental Capacity	Four potential influences in the environment: collective bargaining, civilian review board, accreditation status, civil service	No significant relation between environmental capacity and COP implementation.  No relation with formalization and administrative weight.
	Police Chief Turnover	Number of chiefs from 1970 to 1993	Police chief turnover positively influences COP implementation but has no relation with structural control.
	Age	Estimated age of organization since the agency started uniformed, paid, full-time twenty-four-hour police services	Age of police agency affects COP implementation.  No relation between organizational age, and both structural complexity and structural control of organizations.
	Region	Police organizations located in the West	Significant relation between police organizations in the West and occupational differentiation but no significant relation with stations.

<b>Study</b>	<b>Variable</b>	<b>Measure</b>	<b>Relevant Findings</b>
	Ranks	Number of ranks	Significant relation between number of ranks, formalization, and administrative weight.

### **Summary of Organizational Coordination and Control**

Each layer at the administrative level that regulates the processes of organizations is likely to be conceived as another barrier to reaching the goals and objectives of police agencies. The meaning of the term *barrier* is twofold here: It either contributes to the reaching of certain outcomes via regulations and rules or prevents certain processes that may enhance the quality of police practices. Either way, it is important to discuss its interpenetration in police agencies concerning digital forensics practice.

The present part of the study reviewed the variables that drive structural coordination and control of organizations. Each factor mentioned above was delineated to describe the way in which this study explains the adoption of digital forensics practice theoretically from the perspective of structural coordination and control. According to system theory, there is no perfect system in any given social organization, and social systems are prone to making mistakes or exceptions to their regular duties. Structural coordination and control mechanisms play a part in proceeding to certain objectives and outcomes for police agencies to act systemically. Hence, it is necessary to discuss and measure the degree to which coordination and control dynamics play a role in adoption of digital forensics practice.

### **Adoption of Innovation**

Because the tools of organizations are always inadequate, organizations are not perfect in regard to fulfilling expectations (Etzioni, 1960). Therefore, institutions are prone to change and

expand their operations as they encounter new ideas and challenges (Weisburd, 2006). Ideas and practices, as long as they are perceived as new, are considered innovative (Rogers, 2003).

Current policing is highly influenced by innovation. However, the varying nature of innovation in different police agencies is questionable. Why some police departments are more innovative than others is not quite understood (King, 2000).

Digital forensics practice is an innovation of the last few decades that has been adopted by many police agencies. Digital forensics practice contains highly advanced technology compared to many other specialized practices in police agencies. As a recent foundation of forensic science and a product of many disciplines, the nature of digital forensics practice may have limited organizational scholars' curiosity about research on the matter. Hence, the present study will look into the degree to which police agencies have adopted digital forensics practice with the following concept.

**Degree of Adoption of Innovation: Radicalness (Dependent Variable)**

A practice must be adopted in order to be practiced. Otherwise, we would refer to the short-term implementation of different fields in organizations as testing, as long as no decision was made to utilize such practice in the future. Hence, needless to say, digital forensics practice is bound to its adoption. Some police agencies in the U.S. do not address digital forensics practice at all. However, many police agencies have adopted digital forensics practice to varying administrative degrees, from incremental to radical. It is important to describe the variation in addressing digital forensics practice to understand the trend in police agencies and construct a relation with other concepts.

The degree of adoption of innovation has been described by organizational scholars. Damanpour (1998) stated that organizational research should contemplate the necessity of differentiating factors of radical and incremental innovations. Dewar & Dutton (1986) classified high-degree new knowledge in organizations as radical innovation and low-degree new knowledge as incremental innovation. They claimed that the degree of change in organizations ranges in a continuous pattern. Nonetheless, it is hard to differentiate the mid-values of such a range. Damanpour (1991) stated that the structure of organizations changes according to the adoption of innovation; however, the degree of these changes may not be same for all organizations. The present study determined the extent of the change in police agencies concerning the adoption of innovation related to the organizational attributes of police agencies.

### **Major Studies of Adoption of Innovation**

The reasons behind the adoption of new practices within police agencies have been increasingly scrutinized by police organization scholars. Katz (2001) stated that little agreement exists as to why specific specialized units were created and how police agencies addressed local problems originally. Mullen (1996) explained the organizational and environmental characteristics of computerized versus noncomputerized police agencies; King (1998) analyzed the correlates of 10 different police innovation types; Katz (2001) questioned the factors that led to the creation of gang units in police departments; Chamard (2003) investigated the adoption patterns of computerized crime mapping; Weisburd & Lum (2005) analyzed the reasoning behind the adoption of computerized crime mapping; Giblin (2006) examined the incorporation of crime analysis units; Maguire (2009) delved into the effects of formal police organizational control on child sexual abuse case attrition. Each study sought to identify the effects of certain

organizational features on either the adoption of new practices or their incorporation with police practices in police agencies.

### **Innovation in Police Agencies**

Social change occurs when new ideas are invented, diffused, and adopted, which creates certain results (Rogers, 2003, p. 10). The new agenda of the 21st century has resulted in many changes affecting police services (Hodgson & Orban, 2005). The progress and change in American police departments is a product of their history. Many fundamentals of policing, such as practices and procedures, including problems, have a longstanding existence (Walker & Katz, 2008). The longstanding problems of policing and the abundance of change in policing and police organizations should not surprise anyone, as police organizations have experienced many changes along with the society they are part of. The spread of change is usually related to the technological capacity or organizational design of the organization in which the changing problems and necessities of communities are addressed over time.

Various innovations have been considered by criminal justice scholars. Among police innovations, the enormous effect of communication technology in changing policing is undeniable. Telephones, two-way radios, and patrol cars and their linkage to each other are the major changes that have facilitated communication in police agencies (Walker & Katz, 2008). Innovations concerning homeland security, the militarization of police, the fear of crime, and new types of crime in addition to concerns about police management, training, and police operations have been the focus of policing within the last century (Hodgson & Orban, 2005, p. 6). Moreover, the change in policing could be seen in terms of organization, operation, and reforms for improving policing. Among well-known changes in policing, racial profiling, patrol



cars, handling domestic violence, community policing, and problem-oriented policing could also be counted (Walker & Katz, 2008).

### **Adoption of Innovation: Historical Perspective for Police Agencies**

Two major innovation initiatives attract the majority of organizational scholars' attention in terms of evaluating the radicalness of innovations. First, King (1998) purported that community policing and problem-oriented policing were the only radical innovations. In his study, he examined the radicalness of community policing in municipal police organizations. He claimed that community policing changes the operating system in police agencies for which community policing is considered an example of radical police innovation.

Second, though King (1998) did not consider it in his study because it was not popular at that time, Compstat has become more popular throughout the years and seems to be one of the most well-known police innovations among police practitioners that promote radical innovation in policing. It changed the implementation of policing and blended technology into traditional policing. Willis, Mastrofski & Weisburd (2007) stated that Compstat is the most recent police innovation that includes interconnected administrative and technological components affecting the capability of policing radically. Weisburd, Mastrofski, McNally, & Greenspan (2002) stated that Compstat contributes to traditional police organizational controls by adopting innovative technologies and adding problem-solving skills.

### **Compstat**

Kelling and Sousa (2001) stated that Compstat appeared in the 1990s as a novel approach to policing in which police practices and reserves were administrated with new methods. Kelling and Sousa (2001) claimed that "Compstat was perhaps the single most important

organizational/administrative innovation in policing during the latter half of the 20th century” (p. 2). The Ford Foundation and John F. Kennedy School of Government at Harvard University deemed Compstat worthy of the Innovations in American Government Award (Giuliani, 2002).

Silverman (2006) stated that the major components of Compstat are “computerized crime data, crime analysis, and advanced crime mapping as the bases for regularized, interactive crime strategy meetings that hold police managers accountable for specific crime strategies” (p. 268). According to George Gascón (2005), assistant chief and director of operations of the Los Angeles Police Department, Compstat has the capacity to help political bodies investigate the accountability of police executives where the efficiency and effectiveness of resource management is the foremost subject of the investigation. Moreover, Compstat helps calculate the outcomes of the specific practices of police agencies by utilizing crime and arrest information. Compstat also provides a tool for the assessment of each person’s performance in working for police agencies in which the careers of individuals are based on performance accountability.

### **Studies of Compstat and and Adoption of Innovation**

Silverman (2006) stated that Compstat implementations in New York were consistent with the declining crime rates. For example, the city’s crime rate dropped by 12% in 1994 concerning FBI index crimes and dropped by 16% for the following 2 years. As a matter of fact, the declining crime rates in New York formed 60 % of the crime drop across the nation. Yet despite all of the praise and appreciation given by police administrators and politicians to Compstat, Weisburd, Mastrofski, Willis, & Greenspan (2006) claimed that there is not sufficient empirical evidence to support a causal relation between Compstat and its crime-control outcomes. Weisburd et al. argued that Compstat reduces the capability of police agencies to

solve the very problems whose solutions it is supposed to facilitate. For example, agencies that implement Compstat are more concerned with reducing crime and increasing accountability while omitting the fact that street-level policing requires training, skills, and morale to deal with crime and community problems.

Several studies have been performed to measure the impact of Compstat on policing. Vito, Walsh, and Kunselman (2005) surveyed the students at the University of Louisville to obtain their perceptions on Compstat and its best and worst elements. According to the students, Civil Enforcement Units at 68.1% (32/47), the Pattern Identification Module at 34% (16/47), and Establishing Accountability at 27.7% (13/47) were the best elements of Compstat, while the worst Compstat elements were SATCOM at 48.9% (23/47), Civil Enforcement Units at 21.3% (10/47), and Recognizing Officers Who Make Arrests at 14.9% (7/47).

Weisburd et al. (2003) analyzed the diffusion and typology of Compstat in American police agencies. They found that larger police agencies tend to implement Compstat earlier than smaller police agencies. While the researchers were expecting to find differing and more contemporary organizational structuring, they found that police agencies adopting Compstat tend, perversely, toward traditional organizational control and complexity. For example, they tend to keep the same or a similar degree of hierarchical differentiation. This results in information-sharing problems between mid-ranking officers and line officers, which prevent the utilization of greater benefits from the adoption of innovation.

O'Connell (2004) established a typology that defined the characteristics of Compstat and pinpointed the influence of practices that either positively or negatively affected Compstat's progress within NYPD. His study also focused on Compstat's impact on decision making,

communication, and information management processes and the organizational culture of the NYPD. He concluded that Compstat was influential on all of these aspects and that it made a considerable impact on the agency. O`Connell also claimed that Compstat had significantly changed the organizational structure of the police agency. From a historical perspective, this influence might be due to the availability of technologies to process crime-related raw data.

### **Community-Oriented Policing**

The previous two examples about the adoption of innovation are closely related to technology, yet community policing seems a bit outside the box. However, based on many organizational scholars' definitions, I consider technology a method of operation that utilizes processes in organizations in order to reach certain outcomes. These methods could be based on technological devices or methods of operation by individuals, including community policing in police organizations.

As a matter of fact, examining the abundance of studies on community policing reveals extensive data collection concerning community policing by LEMAS and financial support from federal and local officials to perform research on community policing. Although community policing has received significant attention all along, it has relatively little relation to the direct enforcement of the law.

Reeds (1999) stated that community policing is a "model partnership between citizens and police" (p. xi). Trojanowicz (1994) mentioned that the purpose of community policing is to reduce crime and community disturbance. Reeds (1999) mentioned that in high-degree implementations of community policing, community policing is highly dependent on individuals; officers are assigned to patrol the same precinct regularly, where they are bond to a small unit

and engage with citizens while disentangling community problems. Moreover, as Trojanowicz (1994) stated, community policing is active in the sense that it necessitates the collaboration of “local government, civil and business leaders, and public and private agencies” (p. 4).

### **Studies of Community Policing and Adoption of Innovation**

King (1998), in his study “Innovativeness in American Municipal Police Organizations,” drew a parallel between the adoption of innovations by police agencies and the agencies’ environments. King’s study did not focus on the process of innovation; rather, it addressed the adoption of innovation. He scored each of the innovations individually rather than calculating the sum of all innovations in police agencies, as most organizational studies had done up to that point. King focused on large police agencies for three major reasons. First, they contain more necessary differentiation that influences innovation than do small municipal police agencies. Second, even though their numbers are much fewer, municipal police agencies at that time served 48% of the population. Third, the available data was based on large municipal police agencies. For similar reasons, this study focuses on municipal police agencies.

Using the Police Foundation Survey, King (1998) focused on innovation in community policing. He considered whether police departments had both implemented community policing and assigned police officers over the long term. He found that 71.3% of the sample had radically implemented community policing. He found a positive relation between COP implementation and organizational size, specialization, formalization, and police beats; he also found a negative relation between COP implementation and vertical concentration. King also related foot patrol and crime prevention with community policing because foot patrol has the capacity to improve police-community relations and crime prevention necessitates the participation and help of

citizens in crime-related issues. While King asserted the existence of a positive relation between crime prevention and innovations, he found a negative association between foot patrols and innovations in police agencies. This result, as Wilson (2006) stated, might be due to problems in his model and insufficiency in his data collection.

One of the major studies that contributed to the literature on adoption of innovation was Wilson's (2006) study on community policing in America. Like many organizational scholars, Wilson considered community policing an innovation for police agencies. This theory was one of the main reasons behind Wilson's testing of the relation between structural organizational variables and COP, and other types of innovation studies revealed a considerable quantity of findings on the matter. Thus, Wilson decided to perform a similar type of study concerning COP. The present study applies a similar method in relation to digital forensics practice, measuring its relation to structural variables related to municipal police agencies.

### **Crime Mapping**

Crime analysis and crime mapping together have the potential to change conventional policing practices significantly (Manning, 2008). Crime mapping is a component of crime analysis in which crime data can be controlled and processed in order to understand the crime problem visually (Harries, 1999). Crime mapping includes various processes such as "research, analysis, and presentation" (Harries, 1999, p. 35). Crime mapping begins with the processing of received information by data-entry personnel, the submission of crime-related information to a database, and the utilization of information for representation on paper or on a virtual platform such as computer (Harries, 1999).

## **Studies of Crime Mapping and Adoption of Innovation**

Weisburd and Lum (2005) researched the diffusion of computerized crime mapping utilizing the survey records collected by the Law Enforcement Management and Administrative Statistics (LEMAS) and the Crime Mapping Research Center at the National Institute of Justice. They claimed that larger police agencies (police departments with more than 100 sworn officers) adopted computerized crime mapping more broadly and quickly than smaller agencies. The authors also found a relation between hotspots policing and computerized crime mapping. Moreover, the study related the relatively early adoption of crime mapping with police departments' cosmopolitan views, that is, consciousness about the research community and research findings.

Chamard (2003) analyzed the adoption of computerized crime mapping by examining interpersonal informal communications, as well as the reasons for which police agencies discontinued the practice of computerized crime mapping. Specifically, Chamard (2003) examined 347 municipal police agencies concerning their "temporal and spatial diffusion of computerized crime mapping" in New Jersey (p. ii). She found a significant relation between larger police agencies and the adoption of computerized crime mapping. However, this finding seems to contradict her later findings that there is no significant relation between the earliness of innovation adoption and agency size. She justified the earliness of adoption of computerized crime mapping with Harries's (1999) finding that the adoption of crime mapping could be impetuous. Moreover, according to Rogers (2003), in order to measure the earliness of adoption, the adoption of innovation should be in the completion or saturation state. However, as Chamard

(2003) stated, early research on the adoption of innovation could be a straightforward snapshot of understanding regarding what happened concerning the adoption.

### **Gang Units**

According to Thrasher's classical definition, "the gang is an interstitial group originally formed spontaneously, and then integrated through conflict" (1927, p. 46). Katz and Webb (2006), in "Policing Gangs in America," count several types of crimes as part of gang activities: narcotics trafficking, violence in community areas, killing bystanders, and homicides in the neighborhood. Today, gang activity has been associated with a variety of problems in large cities and is considered an important part of the community order problem as reflected by media.

### **Studies of Gang Units**

Contrary to many previously mentioned quantitative studies, Katz (2001) applied qualitative research techniques to analyze information about the establishment of gang units in police agencies. He focused mainly on census data, interviews, and historical-comparative analysis based on institutional theory to analyze the dynamics leading to the establishment of specialized gang units, as well as the impact of these factors on the way gang units approached the community problems in Midwestern (Junction City) police departments.

Katz (2001) interviewed 10 of the gang unit officers as well as nongang unit personnel, including 8 police officers representing 7 different units, 16 members of the Law Enforcement Network/Tracking System, 14 school administrators, and 7 individuals representing eight special interest groups. He focused on the five following matters:

- 1) Perceptions of the gang problem in the respondent's community;
- 2) The nature of the relation between the respondent's unit/agency and the gang unit;



- 3) Influences the gang unit had had on the respondent's unit/agency;
- 4) Advantages of the unit's/agency's relation with the gang unit; and
- 5) Problems that the unit/agency had had with the gang unit. (p. 47)

Katz's (2001) findings were contrary to expectations that the gang units were established because of the staggering gang problem nationwide. In particular, the social and political pressure coming from key stakeholders influenced the police chief's decision to establish gang units, even though he did not believe the gang problem in the community required the adoption of a new unit. The police agency did not resist the institutional pressures of the community and its main stakeholders in order to preserve the legitimacy of the department.

### **Summary**

First, this chapter reviewed three different organizational theories to identify organizational factors influencing the adoption of several types of innovations. Adoption of innovation by police agencies varies in terms of the type of adoption, the degree and features of adoption, and the factors impacting the adoption. The literature review brought many insights to the study in terms of how police agencies were theoretically approached by organizational scholars, which factors were the most commonly researched, and the dynamics influencing the adoption of innovations. By considering these organizational theories, relevant correlates of the adoption of digital forensics practice by large police departments in America were explored.

Police agencies have been considered open systems in many organizational studies. This consideration has caused organizational scholars to analyze police agencies from a variety of angles, which has resulted in the examination of an abundant number of dynamics. Hence, examination of the literature and its scope was necessary to categorize those dynamics in order to

examine the varieties of organizational behavior in their appropriate contexts. The extensive research on several variables was also conducted in order to discover potential explicatory variables that might explain the adoption of innovation in local police agencies.

The primary factors aiding in the assessment of innovation adoption are external factors (environmental factors) and internal factors (structural control and complexity). Most organizational studies converge on measuring the significance of environmental variables for police agencies, such as complaint review boards and population diversity, economics, education, and others. Most organizational studies also tend to focus on internal features of organizations such as formalization, size, task scope, centralization, administrative weight, spatial and occupational differentiation. What has not theoretically converged in most studies is the type of police practice, which varies from one type of local police agency to another. Considering many dynamics in the literature, the present study utilized a set of variables to explain the adoption of innovation in digital forensics practice based on the literature. Initially, many factors were considered and evaluated. However, the limited amount of data available from police departments prevented a comprehensive assessment of all predictors or explanatory factors of the variation in digital forensics practice.

## **CHAPTER IV: UNDERSTANDING DIGITAL FORENSICS PRACTICE**

### **Introduction**

The aim of this chapter is to explain digital forensics practice in police agencies. The practice of digital forensics is a wide-ranging field in which several issues, including cybercrimes, digital evidence, crime scene management, digital forensics practice, and the investigation of digital evidence, play an important role in the handling of digital evidence by police agencies. The first part of this chapter, Cybercrimes and Digital Forensics Practice, will address cybercrimes, digital evidence, and digital forensics practice more broadly. The second section of the chapter, Digital Forensics Practice in Police Agencies, will delve into the specifics of digital forensics practice as implemented by American police agencies.

### **Context**

The practice of digital forensics has not developed in the same way as other forensic science practices. Casey (2004) drew attention to several issues related to digital evidence. For example, differentiation of tasks via specialization in the field of digital forensics has not been completed, and training is also inadequately provided due to incomplete understanding of the discipline. Moreover, the reliability of evidence is at stake as a result of methodological problems in digital forensics investigations.

The main focus of digital forensics practice is to provide services and mission stability in formal organizations. Although presentation of digital evidence is an outcome of forensics practice, it has become a byproduct of delivering digital forensics services. Therefore, research on digital forensics should focus on paradigms of the procedural, social, and legal fields that are

directed toward healing the disarrays of digital forensics practice rather than focusing on constantly evolving digital technologies (DFRWS, 2001).

The capacity to deal with digital forensics practice in police agencies is unknown. Police agencies adopt the practice at will, and willingness to adopt has not been described by empirical studies. The adoption of digital forensics practice has received very little attention from organizational scholars. Considering the number of police agencies in America and the number of studies on other fields of policing, I assert that the adoption of digital forensics practice requires attention on the part of organizational scholars as well. Digital forensics practice has become part of police agency practice is and highly convoluted. Leaving digital forensics practice unexamined would result in a failure to understand the way police agencies deal with cybercrimes and digital evidence, as well as the capacity of police agency efforts directed towards digital evidence.

### **Cybercrimes and Digital Forensics Practice**

#### **Cybercrimes**

The definition of *cybercrimes* is somewhat complicated, as there are many differing approaches to the topic. Two major perspectives have dominated the discussion about cybercrimes. The first one sees cybercrimes as a transformed form of traditional crime, and the second one view cybercrime as a new type of crime.

Reyes, Britton, O'Shea, & Steel (2007, p. 7) stated that most cybercrime has its roots in old-fashioned crime. He asserted that criminal “mischief, larceny, or destruction of property” cases, which involves computers, have been explained as computer-tampering cases in the cyber-world. Moreover, harassment involving computers has been attributed to cyber-stalking. He also

claims that cybercrimes should be explained in the form of true crimes. Using the words such as “was wronged” or “sexually exploited” could make cases more understandable than explaining them by attaching the word “cyber” to criminal behaviors.

The above approach resembles the Department of Justice’s (2000) claim, which proposes applying the same rules and principles to cybercrimes as are applied to conventional crimes:

Substantive regulation of unlawful conduct (e.g., legislation providing for civil or criminal penalties for given conduct) should, as a rule, apply in the same way to conduct in the cyberworld as it does to conduct in the physical world. (Para. 35).

Nonetheless, not everybody agrees that approaching cybercrime as simply an “attachment” or “transformation” to traditional crime. Katyal (2001), former Principal Deputy Solicitor General of the United States, claimed that identifying cybercrimes as fundamentally the same as traditional crime could lead to unexpected results. Treating cybercrimes identically to traditional crimes may encourage criminals to commit crimes in cyberspace. As well, disproportionate punishment, whether for crimes committed in real space or cyberspace, would tempt criminals to move their criminal behaviors into fields that entail less cost and less risk of punishment. For example, thieves will be more inclined to steal from electronic resources than from physical places such as banks, crimes against which require more resources, greater risks, and harsher punishments. Hence, Katyal (2001) suggested that increasing the sentence for crimes committed in cyberspace could deter the commission of crimes in cyberspace.

Katyal offered three factors that make cyberspace unique in terms of crime. First, cyberspace provides a cheaper environment in which to commit crime with the help of apparatus such as computers and network devices. Second, although traditional crime has partakers that

include both perpetrator and victim, cybercrime comprises extra parties that are used as a base for perpetrating cybercrimes. The major actor is usually the ISP (Internet Service Provider), whose security policies could increase the cost of committing cybercrimes. Third, cyberspace provides anonymity to others, including both victims and third parties. This creates constraints in preventing such crimes due to the lack of effective means for imposing social norms on the Internet.

### **Categorizing Cybercrimes and Cyber Criminals**

The exploitation of technology through criminal activities has made necessary new terminology and the reclassification of criminal activity (Moore, 2005). The term *cybercrime* is alternatively referred to as *computer crime*, *information crime*, and *high-tech crime* (Volonino, Anzaldua, & Godwin, 2007). Basically, two types of offenses are referred to as cybercrime: (a) those that target computers, and (b) those that use computers as instruments for committing a crime. Attacks on networks that cause computers to crash and attainment of unauthorized access to information systems, programs, or data are the major examples of crimes in which computers are targeted. Crimes committed with a computer support, such as espionage, theft, fraud, forgery, stalking, or distribution of child pornography, exemplify cases of computer use to support crime (Volonino et al., 2007, p. 6). The use of computer support is also defined as computer-related crime, that is, “any criminal activity that involves use of computer technology, directly or indirectly, as the instrumentality or objects of the commission of a criminal act” (Clark & Diliberto, 1996. p. 9).

Although society conceives of cybercrime as a familiar term and the concept has been involved in many parts of life, the definition of cybercrimes is somewhat varied (Gordon & Ford,

2006). Wall (2007, p. 10) defined cybercrimes as “criminal or harmful activities that involve the acquisition or manipulation of information for gain” and conceived of it as “the transformation of criminal or harmful behavior by networked technology, rather than simply the behavior itself.” For instance, the involvement of a computer in order to defraud someone is identified as *computer fraud* or *electronic fraud* (Volonino et al., 2007). Stephenson (2000, p. 3) simply defined cybercrime as “crimes directed at a computer or a computer system.” No consensus has been reached regarding the definition of cybercrime, causing interpretational discrepancy. This study conceives of cybercrimes, whether computers are used as an instrument or target, as any behavior based in cyberspace that violates criminal law.

### **Crime Rates**

The development and spread of information technologies in recent years has resulted in unprecedented changes in social life (Kovacich & Jones, 2006). The profusion of computers used in homes and business, especially joined with high-speed networks, has triggered a surge in illegal endeavors involving computers as one of the criminal’s favorite tools.

When dealing with digital evidence, local police agencies handle a variety of cybercrime cases ranging from hacking and phishing, to child pornography, to helping other units find necessary information on the computer of a victim or offender. As digital forensics must deal with all sorts of crime-related evidence on computers, it is impossible to obtain exact information about the quantity of digital evidence examined by police agencies. The amount of media and their storage capacity on each computer varies dramatically. However, collecting information about cybercrime rates across America could be significantly easier and would offer an idea of current rates of digital forensics examination.

The Internet Crime Complaint Center (IC3), a partnership between the Federal Bureau of Investigation (FBI), the National White Collar Crime Center (NW3C), and the Bureau of Justice Assistance (BJA), focuses on cybercrime complaints. The organization functions as a hub to receive, develop, and refer criminal complaints. In 2007, 205,884 online complaints were received by IC3 and the number of online complaints decreased by only 0.3%, while the dollar loss incurred by referred complaints reached \$239.09 million (IC3, 2008, p. 2). A staggering increase in IC3 complaints was evident in the 2008 IC3 report, which indicated the largest increase so far. The IC3 Web site received 275,284 complaints, representing a more than 33% increase from 2007's number of complaints.

According to the 2007 IC3 report, the most frequently reported claim is auction fraud, at 35.7%. Nondelivery accounts for 24.9% of complaints, and confidence fraud accounts for 6.7% of complaints. Combining credit and debit card fraud, check fraud, and computer fraud complaints accounts for 17.6% of all referred complaints (National White Collar Crime Center, Bureau of Justice Assistance, & United States & Federal Bureau of Investigation, 2009, p. 5). A significant change was evident in 2008 concerning the characteristics of complaints made. For 2008, nondelivery of merchandise and/or payment accounted for 32.9% of submitted crime complaints—the largest increase among IC3 complaints. Although the last 3 years' data shows a steady decrease, auction fraud retains its place as the second highest category of cybercrime complaints, followed by credit/debit card complaints.



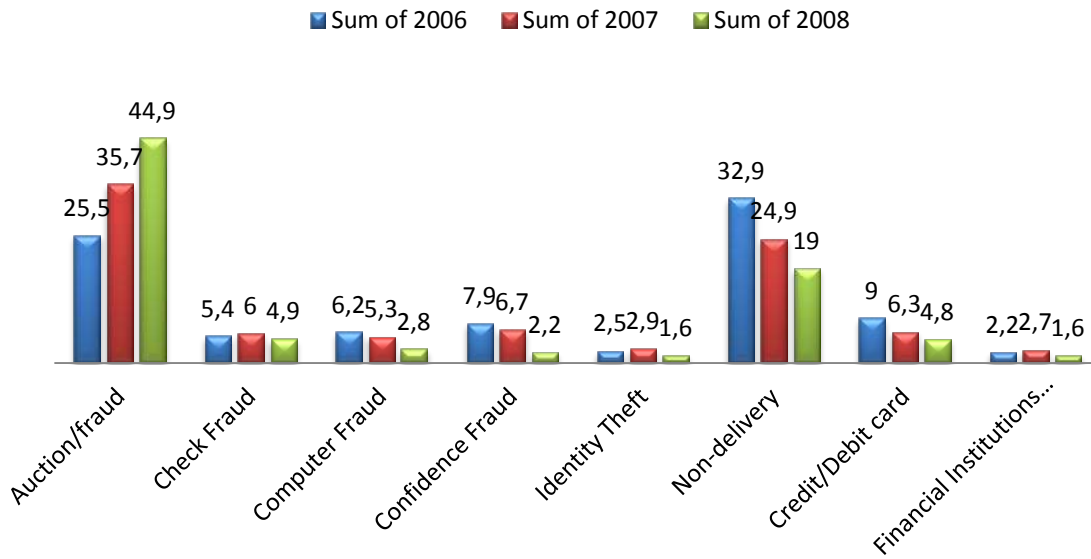


Figure 4. Top critical IC3 complaints categories between 2006 and 2008.

*Note:* % of total complaints received.

The 2007 E-Crime Watch Survey was conducted via the joined efforts of the U.S. Secret Service, Carnegie Mellon University Software Engineering Institute’s CERT® Program, and Microsoft Corporation. The survey was conducted on 671 security executives and law enforcement officials and included issues related to commitment to security, the source of e-crimes, the top e-crimes that professionals are experiencing, methods of attack, security technologies being deployed to defend against attacks, and the legal steps organizations are taking after being attacked. The survey found that 57% of participants were progressively more worried about the possible impacts of e-crime, while 49% of the respondents reported that they had been victims of e-crime in 2006 (CERT, 2007).

The 2007 E-Crime Watch Survey results did not indicate a significant change in cybercrime, yet spam email increased from 40% to 53% and phishing attacks increased from 31% to 46%. According to the survey results the top five e-crimes committed by outsiders were virus, worms or other malicious code (experienced by 74% of respondents); unauthorized access to/use of information, systems or networks (experienced by 55%); illegal generation of SPAM email (experienced by 53%); spyware, not including adware (experienced by 52%); denial-of-service attacks (experienced by 49%); and phishing (experienced by 46%).

Approximately a quarter of all businesses suffer asset loss due to computer crimes. Moreover, most companies do not admit their losses or report them to law enforcement agencies because they do not have confidence in the ability of digital forensics units (Clark & Diliberto, 1996). Although many problems exist in regard to reporting of cybercrime cases by companies and institutions, an increasing effort is being made to measure their losses. The CSI Computer Crime and Security Survey was conducted by Computer Security Institute. The survey included 443 information security and information technology professionals in United States corporations, government agencies, financial institutions, educational institutions, medical institutions, and other organizations. The survey results indicated that average economic losses due to security incidents decreased from \$289,000 per respondent to \$234,244 per respondent in 2009. Financial fraud (19.5%) increased by more than 12% and malware infection (64%) increased by more than 50% last year. Similarly, denials of service (29%) and password sniffing (17.3%) were on the increase. In contrast, wireless exploits and instant messaging decreased by about 10% last year (Computer Security Institute, 2009).

## **Underreporting**

Underreporting cybercrimes leads to a lack of adequate knowledge about the characteristics of victims. In order to gain real knowledge about cybercrime victimization, victimization surveys about cybercrimes have to be widespread enough to represent the nation's pattern of victimization. Lack of knowledge about cybercrime victimization will cause insufficient resource assignment for the solution of the problem by police agencies (Wall, 2007). Police agencies respond to cybercrimes by utilizing digital forensic labs. Digital forensics labs must overcome enormous amount of backlogs, just as do traditional forensic labs. Tremendous numbers of digital evidence cases await the examination of digital forensics examiners, often for months. Hence, there is a significant need for the support of NCVS, UCR, and other credible systems to collect information about the quantity of digital evidence examined in digital forensics labs, as well as information about the amount of backlogs at each police agency.

## **Forms of Cybercrime**

Committing a cybercrime can be as easy as shoplifting at a poorly surveilled store.. In order to forge a credit card, only simple technology is needed. Using a forged credit card is secure enough for at least a few rounds of use (Lampson, 2004). Anonymity makes it possible to apply fraudulently for online applications for bank loans, credit card accounts, insurance coverage, and health care coverage. Anonymity also makes it possible for employees to misappropriate resources unlawfully from corporate resources. Privacy protections make another contribution to anonymity, despite the fact that they make cybercrime investigations much harder (Oates, 2001). A wide range of illegitimate materials has been spread out anonymously via the Internet worldwide. This anonymity makes it harder to track down the identity of criminals

(Zheng, Qin, Huang & Chen, 2003). Criminal investigations have become more complicated due to the widespread use of the Internet, which carries a single point of victimization to several points throughout the world (Gordon et al., 2002).

Many types of crimes involve activities not conventionally considered cybercrimes. For instance, the remains of Chandra Levy, the missing government intern, were found in Rock Creek Park in Washington, DC after her computer was investigated by digital forensics experts. In that case, there was no relation between her computer and the crime. However, the information available offered enough clues for police to locate her body. Digital forensics examiners discovered when she had last logged on and when she had looked at a map of the park on the Internet (Prosis, Mandia & Pepe, 2003).

The Internet offers a wide range of opportunities for crimes such as fraud and theft, pervasive pornography, and pedophile rings. Nonetheless, cybercrimes are not limited to these types. Transnational crime has become a significant matter in the last century (Hodgson & Orban, 2005). Organized crime syndicates such as drug traffickers are inclined to identify and seize occasions to conduct their illegal activities. Electronic commerce and the Internet have brought new opportunities for illicit profit to criminal organizations (Williams, 2001). Organized crime and online cyber-criminals, using complicated Web applications, have created multi-billion-dollar businesses.

Like many criminal groups, transnational terrorist organizations make use of the Internet to disseminate information and enhance their knowledge via computers to infiltrate the United States' critical infrastructure (Wilson, 2005). Cyber-terrorism is considered a potential threat that may lead to compromising computer systems based in government, military, and private

institutions. Nonetheless, no effective cyber-terrorism incident has been confirmed, as most of the technical critical infrastructure is physically and technically isolated from any other networks (Weimann, 2004). Yet despite the precautions, the United States recently discovered that hackers had embedded malicious software into the United States power grid, making the infrastructure potentially vulnerable to further attacks. If the malicious code had not been discovered in 2007, the Chinese government could allegedly have used this vulnerability against the United States in case of a war to turn off the power (Meserve, 2009). Although cyber-terrorism and cyber-spying are considered potentially dangerous, this study focused on local police departments.

Every day large masses of money, information, and power are added to information systems, and criminals have adopted the computer as an instrument (Anson & Bunting, 2007). Willie Sutton, a former U.S. bank robber, was once asked why he targeted banks. His answer was quite simple: "Because that's where the money is" (Icove, Seger, & VonStorch, 1995, p. 3). Today's criminals know where the money is too, and they also know how they can access larger amounts of money and walk away without penalty from a computer crime (Icove et al., 1995). Within the last few decades, the locus of access to money has transferred to online banking, keeping bank branches less busy. Cyber-criminals do not spend time or energy or take risks by attempting bank robberies; now they can transfer money that is accessible online, either in small chunks or larger chunks, to their desired bank accounts while they are sitting comfortably in a chair and eating a sandwich.

Various business sectors make use of information system technologies in computerizing many applications. For many organizations, data are the most critical resource, creating a demand for effective ways of accessing data, sharing data, and extracting information from that

data (Kumar, Srivastava, & Lazarevic, 2005). Now businesses store their critical information in electronic storage, which is dependent on computerization. Businesses must deal with the cost and effort of securing that information from persons who hunt for illegal access to it (Gordon et al., 2002). For instance, in 2004, Sasses, a type of network worm, targeted computer systems throughout the world, ironically crashing the Luxembourg airport's reservation desk while the delegates of a computer security conference were returning home (Coren, 2005).

Networks provide opportunities for using computers persistently where computers and networks are associated with incidents and crimes (Mandia, Prorise, & Pepe, 2003). Advanced technology provides a means to secure the information that roams on networks. Criminals benefit from high-tech encryption tools, using them to store and transmit illegal data with little worry of detection by the legal system (Gordon et al., 2002). It is hard to locate network-based evidence because it is "volatile in nature, has a short life span, and is frequently located in foreign countries" (Chaikin, 2006, p. 239). Investigators have to overcome two barriers: "identifying the author of a cyber-attack and proving that the author has guilty knowledge" (Chaikin, 2006, p. 239). While the volatility and investigation of electronic evidence are important problems, security threats to technology systems are still on the rise and security spending is insufficient (Jahankhani, Fernando, Nkhoma, & Mouratidis, 2007).

### **Digital Evidence**

DFRWS (2001) asserted that "it is imperative that sound research steeped in the scientific method becomes fundamental to the discovery and enhancement of all tools and technologies employed to assist the courts, including digital forensic evidence" (p. 4).

Digital evidence is a new type of forensic evidence that is stored or transmitted electronically and contains reliable information to support or deny a theory as to how a crime occurred (Casey, 2004; Carrier, 2005; Volonino et al., 2007). Digital evidence provides information about the relation between binary data and the individual considered a suspect (DFRWS, 2001). Developing hypotheses that answer questions about digital events during a digital investigation is essential. The scientific method is used to acquire evidence, and it is important to locate and then test the hypothesis by seeking additional evidence that shows the hypothesis is not feasible (Carrier, 2005).

Digital evidence is fragile, yet it plays an important role in forensic investigations of criminal events. Digital evidence has the potential to be easily “altered, damaged, or destroyed” by unsuitable handling or improper examination (NIJ, 2001, p. IX). Therefore, handling digital evidence requires paying significant attention to keep the evidence safe and unaltered.

Digital evidence is acquired as a physical item, brought together, and stored for examination. Digital evidence (NIJ, 2008, p. IX):

1. Is latent, like fingerprints or DNA evidence.
2. Crosses jurisdictional borders quickly and easily.
3. Is easily altered, damaged, or destroyed.
4. Can be time sensitive.

The complexity level of a digital device that contains digital evidence can be as great as that of the engineering field and the imagination of the engineer who built the digital device. Hence, digital forensics examiners must be extremely knowledgeable about the complexity of the devices they examine during investigations. The nature of digital evidence is very slippery;

sometimes the time required to lose digital evidence can be measured in milliseconds. Moreover, digital evidence can be widespread over as large a range as the extent of the Internet.

### **Digital Forensics**

According to Brown (2006), digital forensics is “the art and science of applying computer science to aid the legal process. Although plenty of science is attributable to digital forensics, most successful investigators possess a nose for investigations and a skill for solving puzzles, which is where the art comes in” (p. 18). The two main branches of digital forensics are computer forensics and network forensics. The former contends with preserving and collecting digital evidence on a standalone machine, while the latter deals with computers connected to each other (Kanellis, Kiountouzis, Kolokotronis, & Martakos, 2006). Network forensics plays a significant role, as computer networks are the heart of America’s operational infrastructure (Mukkamala & Sung, 2003). Nonetheless, computer networks contain several flaws because of their inadequate design, which allows attackers to wipe away the digital evidence from the crime scene (Shanmugasundaram, Memon, Savant, & Bronnimann, 2003).

The concentration point of digital forensics investigation is “some sort of digital device that has been involved in an incident or crime.... The digital device is either used to commit a physical crime or it executes a digital event that violates a policy or law” (Carrier, 2005, p. 3). For instance, use of the Internet to conduct a search about a physical crime would be an illustration of the first circumstance. The second case would be obtaining unauthorized access to a computer in order to download contraband material (Carrier, 2005).



## **Crime Scene**

The digital crime scene is considered exclusive in the digital forensics field. It is hard to locate digital evidence, and digital evidence can also be encrypted with various algorithms (Johnson, 2006). Lack of hands-on information about how to control the situations confronted during cyber-crime investigations is a problem for investigators. Investigators encounter many situations for which there little or no guidance to aid the investigation and decision making. Although the investigators spend time answering hypothetical questions, the results of the investigation may irk the investigator in the end due to lack of definitive guidance or standardization (Reyes, Britton, O'Shea, & Steel, 2007). Everything the investigator uses during the investigation is discoverable during the prosecution process. Any mistake made by investigators can be used against them. For instance, if an investigator uses his or her own computer, on which he or she probably has personal information, for an investigation, the investigation may reveal significant details about the investigator's private life (Casey, 2004).

The plethora of commercial and freeware tools and the use of different investigation models and techniques in digital forensics units increase the variety in forensics investigations. This variety becomes a significant problem when the results of an investigation are presented in court. Judicial systems are formed of strong formal rules, and they expect to receive forensics evidence in a standardized way. The diversity of digital forensic investigation techniques increases the concerns of the judicial system, which requires agreement on the standards of processing digital evidence.

## **Digital Forensics and Police Agencies**

Dealing with crimes is a multifaceted problem that involves a variety of professions including forms of crime, evidence, crime scene, and forensics. The complexity of tools that are used to commit crimes has increased the degree of professionalism necessary in police practices. Cybercrimes that utilize high levels of technology added new kinds of evidence that changed the way police agencies collect and process evidence.

Digital forensics practice is a relatively new field that has been used by many public and private entities on a daily basis as a response to cybercrimes (Busing, Null & Forcht, 2005). Digital forensic examinations are performed in “forensic laboratories, data processing departments, and in some cases, the detective's squad room” (Noblett, Pollitt, & Presley, 2000, p. 2). Digital forensics primarily serves the law enforcement population, in which traditional forensics science is the precedent in terms of the application of statutory conventions (DFRW, 2001). Police departments have established several computer crime units throughout the U.S. (Shinder, 2002), and many of them are dual-purpose, often conducting investigations while also serving as the agency's forensic element (Pollitt, 2009).

Many units in police agencies, such as homicide or sex offense units, tend to request forensic examination of digital evidence, primarily because digital evidence contains a lot of information concerning the whereabouts of victims or offenders, such as where they were shopping, what drugs they purchased, or the location or identity of their contacts. Such information can yield many clues about both victims and offenders.

According to LEMAS-1999 data, 87% of local police agencies do not have cybercrime investigation units. LEMAS (2003) data showed an important increase in the establishment of

cybercrime investigation units, from 13% of police agencies to 22.3%. Although cybercrime investigations are fairly new in the criminal justice system, the fast-growing cybercrime rates may affect the degree of response to cybercrimes by police agencies..

Pollitt (2009) stated that many agencies that do not have digital forensics capacity (the vast majority) send their cases to another department, the state police, an electronic crimes task force (managed by the U.S. Secret Service), or a regional computer forensic laboratory (RCFL, managed by the FBI). Generally, only large agencies such as the Federal Bureau of Investigation (FBI), the Drug Enforcement Administration (DEA), and the DOD (Department of Defense) have dedicated digital forensic units that usually do not conduct investigations, only engaging in examinations.

Noblett, Pollitt & Presley (2000) stated that departmental policy and available expertise often determine the allocation of staff to conduct forensic examinations. A convincing and trustworthy forensic examination is requisite no matter where the examinations are carried out. Pollitt (2001) noted that the number of sworn digital forensics examiners in police department is three times higher than the number of civilian digital forensics examiners. He suggested two promising reasons for the larger number of sworn officers: (a) the computer data is more integral to the case and (b) traditional forensic science laboratories have been slow to provide adequate and timely services (p. D4-91).

Whether digital forensics units have sworn or civilian digital forensics examiners, current data suggest that forensic laboratories have insufficient resources and staff, which in turn creates longstanding backlogs. This situation negatively affects three components of forensics labs: investigations, strong evidence for prosecutions, and accuracy (creating errors that may well lead

to defective justice) (National Academies, 2009). Given that even traditional forensics labs have been struggling with such problems, it is plausible that digital forensics units are experiencing even more significant problems due to the fact that they are recently established units.

### **The Traditional Forensics Practice**

Compared to European forensics system such as Britain's national system of regional laboratories, American crime laboratories are highly independent and locally managed. Almost 350 crime labs have been serving at different levels of government, from federal to municipal, in America. These crime laboratories developed without "national and regional planning and coordination" (Saferstein, 2007, p. 10).

Crime labs in the U.S. have neither defining characteristics nor a definite model due to their size and diversity. Most crime labs are operated as a segment of police departments. Several others function under prosecutors' or district attorneys' offices, and the rest operate with a medical examiner's or coroner's office (Saferstein, 2007). Of all the different forensics agencies serving under different jurisdictions, federal agencies are the most funded agencies with a higher number of personnel. The varying adoptions by different agencies create concerns about "the depth, reliability, and overall quality of substantive information arising from the forensic examination of evidence available to the legal system" (NAS, 2009, p. S-4). According to the National Academy of Sciences (NAS) 2009 report "Strengthening Forensic Science in the United States: A Path Forward," significant variation exists in the characteristics of forensics labs in America. This variation includes various characteristics of forensics labs in regard to "funding, access to analytical instrumentation, the availability of skilled and well-trained personnel, certification, accreditation, and oversight" (p. S-4).

## **Characteristics of Digital Forensics Labs**

### **Task Uncertainty**

Task uncertainty is one of the leading contingencies of organizations (Donaldson, 2001). Task uncertainty is a challenging problem that organizations face when they try to adapt themselves to environmental circumstances (Duncan, 1972) and technological developments (Thompson, 2003). Garner (1962) defined uncertainty as the likely number of products that a task can result in. Understanding the task with its complications will help in planning much of the activities (Galbraith, 1974). Therefore, “the greater the task uncertainty, the greater the information that must be processed” (Galbraith, 1974, p. 28). Uncertainty may also occur outside the organization with varying factors (Donaldson, 2001).

Task variation concerning digital forensics practice is a dilemma in police agencies because the tasks related to digital forensics practice are only limited by the scope of technology.. However, major variation concerning the adoption of digital forensics practice can be observed in police agencies.

### **Task Extraneousness**

Because digital forensics experts are assigned different tasks that are not included in their job definitions, exploring the extraneous tasks assigned to digital forensics experts is important. Police agencies have numerous tasks to perform. Hence, depending on the necessities of the event or situation the police agency is handling, digital forensics experts may be temporarily assigned to different tasks, or they may come across situations outside of their expertise. For example, a digital forensics expert who is also a sworn police officer may have to deal with a traffic accident that is jamming the road while she is commuting to her shift. Digital forensics

experts may frequently be assigned to a variety of tasks against their will. In this case, forensic examination may become an occasional job for the forensics examiner. Specifically, the degree to which the forensics examiner is assigned to extraneous tasks may vary depending on the various organizational attributes of police agencies. While task uncertainty is defined as the likely number of products that a task can result in, task extraneousness concerning digital forensics labs could be described as the number of products that the digital forensics unit/ lab/ personnel produces outside of their area of primary knowledge and the law enforcement related services that are outside of their specific profession.

### **Accreditation**

National Center for Forensic Science (2006) defined accreditation as “the formal recognition by an accreditation body that an organization has policies and procedures considered appropriate to their mission and operates according to those policies” (p. 23). The Committee on Identifying the Needs of the Forensic Sciences Community (2009) stressed that accreditation does not indicate that the forensic lab is error free or always applies best practices. Accreditation basically means that the forensic lab employs standard procedures based on quality principles. These principles are established to arrange satisfactory practices.

Accreditation is provided to an organization and bestowed by an accreditation body that is outside the forensic lab (National Center for Forensic Science, 2006). Accreditation of agencies improves “community ties, transmit[s] best practices, and expose[s] laboratory employees directly to the perspectives and expectations of other leaders in the profession” (Committee on Identifying the Needs of the Forensic Sciences Community, 2009, p. 195).

Accreditation brings synchronization of different forensics labs, which will result in better established standards across forensic labs (Malkoc & Neuteboom, 2007).

Among several other accreditation bodies, two major accreditation boards provide accreditation for digital forensics labs in America: the American Society of Crime Laboratory Directors/Laboratory Accreditation Boards (ASCLD/LAB) and ISO/IEC 17025:2005 (International Organization for Standardization).

ASCLD/LAB has two basic branches: the ASCLD/LAB Legacy Program and the ASCLD/LAB-International Program. The former, which is the traditional one, has served to forensic lab community for more than 20 years. The latter, which was established in 2003, includes the principles of ISO 17025 standards and also the additional ASCLD/LAB-international obligations. The purpose of ASCLD/LAB is to standardize crime labs so that “management, personnel, operational and technical procedures, equipment and physical facilities” constitute certain characteristics of the labs in determination of accreditation. Any forensic lab can partake in the accreditation program to show its eligibility for accreditation (ASCLD/LAB, 2009, para 1).

ASCLD/LAB recognized digital evidence as a discipline in 2003. Subdisciplines in this discipline include audio analysis, digital imaging analysis, video analysis, and computer forensics (Barbara, 2004). Crime labs that apply one of the above practices can apply for accreditation under the discipline of digital evidence. Specifically, the conformity of computer forensic labs to the ASCLD/LAB manual is determined by the following principles: (a) marking, sealing, and protection of physical evidence; (b) validation/verification of procedures; (c) the use of appropriate standards and controls; (d) proper working order for forensic computers; and (e)

the calibration of instruments (Barbara, 2004, para 15). The forensic labs that follow these principles can apply for accreditation of their laboratories (Barbara, 2005).

ISO/IEC 17025 specifies requisites of testing and calibrations that forensics labs must meet. These requisites include a variety of methods including standard to nonstandard and laboratory-developed methods (ISO, 2009). These specifications contain standards on “management system[s] for quality, administrative, and technical operations” (ISO, 2009, para 4). Like ASCLD/LAB, ISO/IEC is germane to all agencies that perform tests or calibrations. ISO/IEC 17025 does not qualify or certificate individuals.

### **Training & Certification**

Digital forensics practice necessitates comprehensive training and the ability to deal with digital evidence. Education and training are usually encouraged or administered by agencies or accrediting bodies (NCFS, 2006). The forms of digital evidence vary—they are complex and change over the years depending on the industrial and technological developments in society. Training is essential to keep up with day-to-day developments and changes in computer technology. Such an evolving process requires constant training of digital forensics experts. Lack of sufficient training will reduce the reliability of forensic experts, who are primarily responsible for the investigation of digital evidence.

The training of forensic experts in police agencies is problematic, as police agencies’ computer forensics labs tend to have smaller budgets than traditional forensic labs. Moreover, sworn police officers who perform digital forensics practice are usually expected to perform additional duties besides trying to keep up with the new technological developments concerning



their expertise. The length and quality of training may vary in the extent to which police agencies' organizational attributes constrain training.

Numerous organizations, from nonprofit associations to vendor-sponsored groups, offer certification programs for those who are willing to become computer forensics experts. Training can be provided either internally or externally. State and federal government agencies are in the process of establishing their own training and certification programs at the most basic level (Franklin, 2006). Major certification programs that provide training in digital forensics field are as follows: The International Association of Computer Investigative Specialist (IACIS), High Tech Crime Network (HTCN), EnCase Certified Examiner (EnCE), and FTK.

**IACIS** is a nonprofit organization supported by the volunteer work of its board members, instructors, and members. IACIS was founded and is maintained by law enforcement professionals who are committed to educating and training law enforcement officials to deal with digital evidence. IACIS's training is based on seizing and processing computer systems; this training is offered once a year. The subject matter changes each year. Attendees are required to take the 2-week Certified Forensic Computer Examiner (CFCE) training and be paying members of IACIS. IACIS® CFCE training is open to any law enforcement officer who is willing to develop herself in the field. IACIS' Advanced Trainings can be taken after being certified as CFCE.

**High Tech Crime Network (HTCN)** offers a variety of certifications: two at the basic level and two other at the advanced level. It is open to people who are involved with the legal aspect of computer forensics, from criminal justice practitioners to corporate communities. The minimum requirement for any sort of certifications is 3 years of experience in the investigation

of technical incidents, technical crimes, or computer forensics (High Tech Crime Network, 2009).

Several other organizations offer a variety of trainings based on the digital forensics software that they have developed. According to the Internet poll conducted by Forensic Focus (2009), Guidance Software's Encase (29,963) and AccessData's Forensic Toolkit (1,819) are the most commonly preferred softwares used by digital forensic examiners for imaging digital evidence in America. Yet these results are comprehensive to all individual examiners in America; neither police agencies' preference of digital forensic software nor their training choices are known, which may influence the quality of digital forensic examination.

### **Age**

The age of a digital forensics practice at a given police agency may reflect greater adaptation to organizational attributes. As digital forensics is practiced for more and more years at a police agency, the practice of digital forensics is likely to experience better coordination and conformation within the police organization.

### **Budget**

In contrast to other types of forensic labs, computer forensic labs can be sustained at relatively low cost and in a small space. Although there are very large digital forensics labs, a well-designed and -supplied small digital forensics lab can perform numerous cases in a given year (Franklin, 2006). Basically, the budget to maintain a digital forensics lab can be divided into daily, quarterly, and annual expenses. The major operating cost of a digital forensics lab consists of computer hardware and software, facility space, and trained personnel (Nelson, Phillips,

Enfinger, & Steuart, 2006). Police agencies' capacity to sustain specialized practices can be observed by analyzing the budget they assign for specialized units.

### **Policy Statement**

To achieve and demonstrate measurable progress toward agency and program goals, the purposeful use of resources and information is necessary (Wholey, 1999). A forensic policy specification is critically needed for many experts and judicial systems. The purpose of the digital forensics unit is to acquire evidence so that the forensic integrity of the data is kept for legal purposes. The capture and preservation of digital evidence are the two main pillars of sound forensic policies. When specifying a forensic policy, the system's functionality is the crucial point that needs to be addressed. The events that must be handled and the data surrounding the events that must be preserved are also essential in the formulation of policy statements (Taylor, Endicott-Popovsky, Frincke, 2007).

### **Digital Forensics Investigation**

#### **Essentials of Digital Forensics Investigation**

Investigation of electronic evidence requires that investigators, forensic examiners, and managers all play a role. Recognition, collection, preservation, transportation, and/or storage of electronic evidence might be a first responder's role. Anyone in the law enforcement profession is potentially a first responder, and forensic experts may aid investigations and perform examinations on the evidence at crime scenes. The training of personnel and provision of equipment are the responsibility of managers (National Institute of Justice, 2001).

Digital forensic examination should be conducted in a secure and trusted environment. Hence, examination may require moving evidence to a new location. Before moving the

evidence, the examiner must “photograph...the evidence, including serial numbers, asset identification, time of departure from the crime, transport of the hardware, arrival time, transport routing numbers, name and title of all handlers of the evidence, and analysis location” (Rittinghouse & Hancock, 2003, p. 345).

Using an operating system or other resources of the systems during the investigation is commonly known as *live analysis*. *Dead analysis* is done when the forensic examiner uses trusted applications in a trusted operating system to find the evidence (Carrier, 2005). A variety of applications of digital evidence investigation can be used by experts. Decision making on what methods should be used according to each different situation requires both training and policy statement in order to preserve the evidence.

Carrier’s 2005 book *File System Forensic Analysis* has quickly become a foundational book for digital forensics investigators. Carrier stated that digital crime scene consists of the digital environment created by software and hardware. The investigation of the digital crime scene is based on three major steps, as depicted in Figure 5.

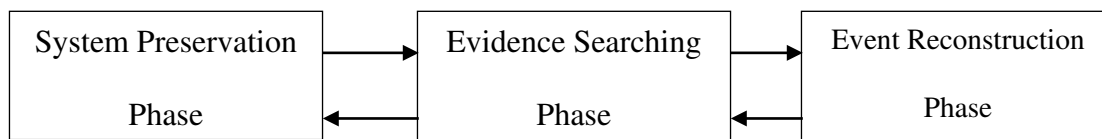


Figure 5: Three major phases of a digital crime scene investigation (Carrier, 2005).

The *system preservation phase* requires the investigator to keep the state of the digital crime scene unchanged. The actions may change depending on the legal, business, or operational requirements of the investigation. The aim in this process is to reduce the amount of evidence that may be overwritten (Carrier, 2005). The *evidence searching phase* usually begins with a survey of common locations based on the type of incident. For instance, if we are investigating

Web-browsing habits, we need to look at the Web browser's cache, history file, and bookmarks (Carrier, 2005). The type of incident and strategy needed to handle the case requires a different sort of analysis approach. The *event reconstruction phase* requires determination of what events happened in the system. The evidence searching phase may help the investigator find the evidence that laws were violated; however, it may not answer the question of how crime is committed using the computer. After the event reconstruction phase, digital and physical events can be correlated (Carrier, 2005).

### **Objectives**

So far, the study has included concepts related to the adoption of digital forensics practice in local police agencies. By considering different theoretical frameworks, police agencies' control over the adoption of digital forensics practice have been assessed from different angles.

The study has in this way discussed knowledge about police organizations and their possible capacity to adopt digital forensics practices. Although I have utilized several theories to delve into different aspects of police organizations, these theories may not have illuminated all aspects of the adoption of digital forensics practice. In order to deal with the lack of knowledge regarding digital forensics practice, I discussed several aspects of digital forensics practice: understanding digital evidence and its nature, as well as the organizational features of digital forensics practice in police agencies.

## CHAPTER V: METHODS

This study utilized secondary data to perform the analysis. Empirical research was employed to investigate the direct and indirect relations of the following latent constructs<sup>4</sup>: environmental constraints, contextual factors, and organizational control of the adoption of innovation.

### Sampling

Organizations have long been a unit of analysis (Maguire, 2003), and “examination of structural features of organizations, their determinants, and their interrelations require the collection of data from a large, diverse sample of organizations” (Scott, 1998, 259). The unit of analysis of this investigation was large local police agencies selected from municipal police agencies. The sampling frame of the study was LEMAS-2003, which consists of 511 local police agencies with 100 or more sworn officers. According to the Census of State and Local Law Enforcement Agencies (2003), about two thirds of the personnel in police agencies are employed by the 6% of agencies that employ 100 or more officers. Local police agencies with 100 or more sworn officers employ 63.6% of sworn officers. Therefore, local police agencies with 100 or more sworn officers represent a great deal of sworn officer employment. This also means that municipal police agencies deal with the larger part of the general population. Sheriffs’ offices are more likely to deal with rural or suburban areas. Thus, they represent only a small proportion of police agencies in terms of the total law enforcement universe.

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<sup>4</sup> For a detailed description of the method, see the appendix.

The LEMAS-2003 survey included 955 self-representing agencies with 100 or more sworn officers. Of the 995 self-representing agencies, 574 of them were municipal police departments and 332 of them were sheriffs' offices as self-representing (SR) agencies. Of the 574 municipal police agencies, 511 of them had actual paid sworn officers with arrest power. The response rate to the survey concerning municipal police departments was 92.1%, which was a little higher than the response rate of the sheriffs' offices, which was 87.0%.

Data concerning administrative weight were obtained from LEMAS-1999. This study also drew data from Maguire's survey concerning municipal police agencies due to lack of available data in LEMAS-2003 on the number of ranks for local police agencies and centralization. Of the 482 police agencies included in Maguire's data set, 83 have missing data concerning number of ranks. I eliminated those agencies that have no rank or centralization data. Therefore, this study included all departments that had complete data on all variables that could be joined with the data set obtained from LEMAS-2003.

To normalize the data set statistically, police agencies that employ more than 3000 full-time sworn officers were removed from the data set, such as New York City Police Department, Chicago Police Department, Los Angeles Police Department, Philadelphia Police Department, Baltimore City Police Department and Houston Police Department. Using the standard query language, (SQL) removing significant outliers as numerically distinct from other values, and joining up of different data sets resulted in a sample size of 345 agencies. In most studies that use structural equation modeling, cases are analyzed between 200 to 400. Therefore, the number of cases analyzed in this study was in the normal range as compared to other studies. Most of the

large local police agencies adopting digital forensics practice, from LEMAS-2003, were represented in the dataset of this study.

## **Data Source**

### **LEMAS**

The Bureau of Justice Statistics' Law Enforcement Management and Administrative Statistics (LEMAS) survey is the most extensively used data source delineating police practices across the nation (Weisburd & Lum, 2005). The secondary data consist of the LEMAS survey for year 2003 and minor data from LEMAS-1999. The LEMAS survey is a highly plausible dataset that has been collected and tested for many years and is used by many organizational study scholars within the criminal justice field. Specifically, the survey collects data from various state and local police agencies, describing various aspects of police agencies, such as personnel, expenditures, functioning, and written policies all across the nation. Moreover, the study was conducted every 3 to 4 years and covers three main types of law enforcement agencies: state police, local police, and sheriffs' departments (U.S. Department of Justice, n.d.). At the time this study was initiated, only LEMAS 2003 was available and LEMAS 2007 was not and various variables that this study was concerned about are not included in 2007 version of LEMAS.

### **Operationalization of Variables and Concepts**

This section, as shown in Table 4, provides detailed information about the operationalization of concepts used in this study, that is, the level of measurement and data elements drawn from LEMAS to measure the concepts included in the measurement model.



Table 4: Operationalization of Variables

<b>Variable</b>	<b>Level of Measurement</b>	<b>Attribute</b>	<b>Question</b>	<b>Source</b>
<b>Environmental Constraints</b>		Latent Exogenous Variable		
Partnership	Interval	Exogenous Variable	Q 31 During the 12-month period ending June 30, 2003, did your agency have a problem-solving partnership or written agreement with any of the following? (Additive index)	LEMAS-2003
Citizen (Complaint) Review Boards	Nominal	Exogenous Variable	59a. Is there a civilian complaint review board/agency in your jurisdiction that is empowered to review use of force complaints against officers in your agency? YES/NO	LEMAS-2003
Regional Location	Nominal	Exogenous Variable	In which region is the police agency located?	Self-collection
Population of the municipality the department serves	Interval	Exogenous Variable	2003 Population	LEMAS-2003
<b>Contextual Factors</b>		Latent Exogenous Variable		
Number of Sworn Officers	Ratio	Exogenous Variable	Q3.a Sworn personnel with general	LEMAS-2003

<b>Variable</b>	<b>Level of Measurement</b>	<b>Attribute</b>	<b>Question</b>	<b>Source</b>
Task Scope	Ratio	Exogenous Variable	arrest powers * authorized full-time paid positions Q1. Which of the following functions did your agency have PRIMARY responsibility for or perform on a regular basis during the 12-month period ending?	LEMAS-2003
<b>Structural Complexity</b>		Latent Exogenous Variable		
District/precinct/ division stations	Interval	Exogenous Variable	2. Enter the number of facilities or sites (three different), separate from headquarters, operated by your agency as of June 30, 2003.	LEMAS-2003
Fixed neighborhood/ community stations	Interval	Exogenous Variable	2. Enter the number of facilities or sites (three different), separate from headquarters, operated by your agency as of June 30, 2003.	LEMAS-2003
Mobile neighborhood/ community stations	Interval	Exogenous Variable	2. Enter the number of facilities or sites (three different), separate from headquarters, operated by your agency as of June 30, 2003.	LEMAS-2003
Occupational	Ordinal	Exogenous	3. Enter the number of	LEMAS-

<b>Variable</b>	<b>Level of Measurement</b>	<b>Attribute</b>	<b>Question</b>	<b>Source</b>
Differentiation		Variable	authorized full-time paid  agency positions and ACTUAL full-time and part-time paid  agency employees	2003
Hierarchical Differentiation	Ordinal	Exogenous Variable	Number of ranks	Maguire (98 data)
<b>Structural Control Factors</b>				
Formalization	Ordinal	Exogenous Variable	56. Does your agency have written policy directives on the following?	LEMAS-2003
Administrative Weight	Ratio	Exogenous Variable	computed by dividing administrative full time employees to all officers	LEMAS-1999
Centralization	Ordinal Scale	Exogenous Variable	index 0 stands for low centralization while 80 represent high centralization	Maguire (1998)
<b>Adoption of Innovation</b>	Ordinal Scale	Latent Endogenous Variable	27. How does your agency address the following problems/tasks?	LEMAS-2003

### **Environmental Constraints**

Environmental constraints are influential in changing or constraining the behavior of police agencies. As Maguire (1997) stated, “No judgment is made here about the effectiveness of these types of organizations for achieving their desired ends—the only assumption is that they all impose limits (in some way) on a police organization’s autonomy.” (p. 127). Factors that are

presumed to be influential in structuring police organizations and adoption of innovation are civil service, partnership, citizen (complaint) review boards, and location of police agency.

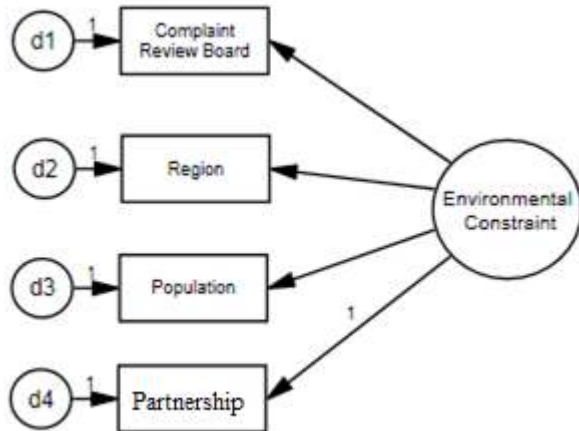


Figure 6: Generic Measurement Model for Environmental Constraints.

### **Partnership**

The inquiry was concerned with whether the agency had a problem-solving partnership or written agreement with unions, such as advocacy groups and school groups. This information was available in the LEMAS-2003 survey. An additive index was used to compute the overall weight of partnership.

### **Citizen (Complaint) Review Boards**

Using the LEMAS-2003 survey, the information about the authorization of complaint review boards against police officers in local police agencies' jurisdiction was utilized as a dichotomous variable.

### **Regional Location**

According to Wilson (2006), police organizations' location in the U.S. West had a significantly important relation with occupational differentiation, and the impact of regional

location to structural complexity was significant as well. The present study used a dichotomous variable, including western police agencies and nonwestern police agencies, to measure the impact of the regional location of police agencies. The data were computed utilizing the list of regions of the United States.

### **Population**

Police agencies exist because the populations in their jurisdiction exist. Needless to say, without a population, a police agency cannot exist. The impact of population on police agencies' organizational structure and adoption of innovation should be addressed. The study used LEMAS-2003, which provided population data for all police agencies.

### **Contextual Factors**

#### **Number of Employees**

This study measured the size of police agencies as the number of sworn full-time employees. This information was drawn from the LEMAS-2003 survey.

#### **Task Scope**

Task scope includes primary responsibilities that the police agency as a whole performs on a regular basis. LEMAS-2003 includes 37 different tasks performed by the police agencies. The questions are in binary form, which indicates whether police agencies practice certain tasks. I formed an additive index for only the law enforcement functions, traffic and vehicle-related functions, and criminal investigation section of the first LEMAS-2003 questions, which are directly related to the criminal investigation capacity of police agencies. Those sections of the

first questions consist of 14 binary questions concerning whether police agencies perform specific investigative functions on a regular basis.

### Organizational Control

Organizational control, a second-order construct, is composed of two related constructs: structural control and structural complexity. Structural complexity consists of spatial differentiation, occupational differentiation, hierarchical differentiation, and functional differentiation. The elements of structural control are centralization, formalization, and administrative weight. The following section of the study will explain the collection method concerning the two main elements of organizational control.

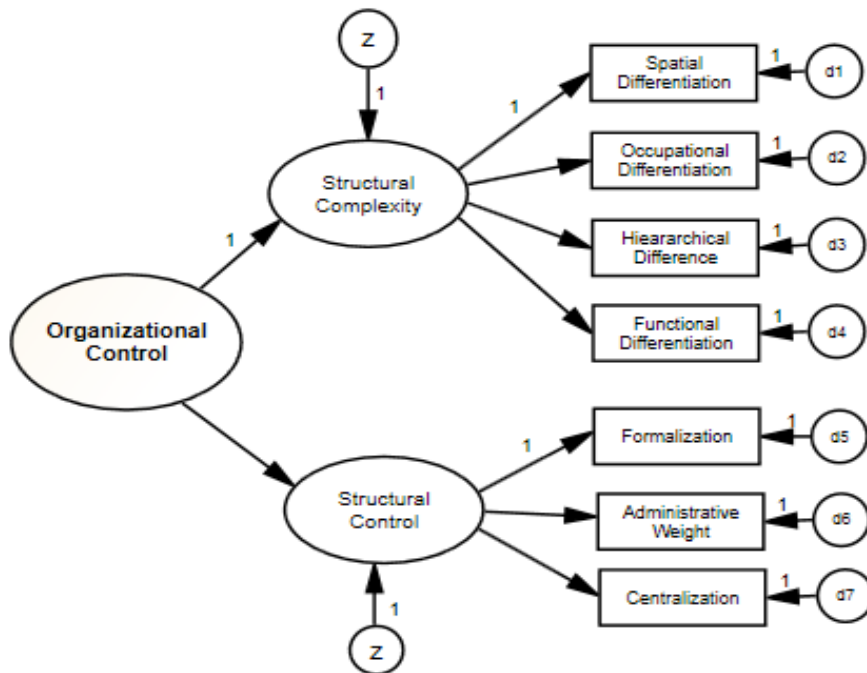


Figure 7: Generic Measurement Model for Organizational Control

## **Structural Coordination and Control Variables**

### **Centralization**

In order to measure centralization, this study used Maguire's (2003) index of survey items, which he adopted from Robbins (1987, pp. 491-493). Maguire (2003) developed a 20-item survey to determine in which levels decisions are made in police agencies. The first 10 questions were asked of the police chief executive and his/her immediate subsidiary personnel in order to figure out their impact on decision making in cases of critical situations. The second 10 questions were asked of lower-level managers (i.e., sergeants) to determine their impact on strategic and operational situations requiring decision making. The question items were classified using a Likert scale ranging from 0, demonstrating low centralization, to 4, indicating high centralization. Later, all responses were summed to establish a complete representation of centralization. To sum up, in the overall index 0 stands for low centralization while 80 represents high centralization.

### **Formalization**

Formalization was measured to discern whether the police agency has a written policy on specific police operations or procedures. The LEMAS 2003 survey provides 15 question items that are in binary form. I will use an additive index to measure formalization in police agencies.

### **Administrative Weight**

Administrative weight was computed by dividing the number of administrative full-time employees into the total number of officers. Because LEMAS-2003 does not contain questions related to administrative weight, the information concerning administrative weight was obtained from the LEMAS-1999 survey. The time range between LEMAS-2003 and LEMAS-1999 is not

long in terms of consideration of administrative weight. It is unlikely that significant changes occurred in the number of administrative personnel between 1999 and 2003, as the number of administrative positions usually does not fluctuate dramatically over a few years.

### **Structural Complexity**

The following elements of structural complexity will be collected using the LEMAS-2003 survey: spatial, functional, and occupational differentiation.

### **Spatial Differentiation**

First, Langworthy (1983) considered the number of stations and number of day or night beats to measure spatial differentiation. Later, Maguire (2003) used the same concept and utilized spatial differentiation as a latent construct. Wilson (2006) mentioned that spatial differentiation has been calculated as the number of facilities or stations that the police agency manages. Spatial differentiation will be measured by collecting data concerning the number of facilities or sites that are not part of the headquarter police department. This information was available from the LEMAS-2003 survey. Three types of facilities were included in the survey: district/precinct/division stations, fixed neighborhood/community stations, and mobile neighborhood/community stations.

### **Occupational Differentiation (Civilianization)**

Langworthy (1983) measured occupational differentiation as the ratio of civilians employed by the agency to the total number of sworn officers. Maguire (2003) did not employ occupational differentiation because, he asserted, the differentiation between civilian workers and sworn officers did not reflect specialization. For example, civilians are assigned many positions, including clerical and technical duties.



Although Maguire (2003) might be correct in his claim to a certain degree, it is possible that measuring the number of civilians would offer an idea of how much the police agency differentiates its functions between civilians and sworn officers. Depending more on civilian personnel might mean that the agency is contingent more on civilians concerning administrative functions. This might also mean that the agency is more keenly focused on the internal functioning of the agency, as most nonsworn employees are assigned inside the police headquarters. The present study drew the data from LEMAS-2003 and utilized it by dividing the number of civilians by the number of sworn officers.

### **Hierarchical Differentiation**

The study counted the number of police officers' ranks (segmentation) to determine the organizational hierarchy in police agencies using the 1993 data obtained from Maguire (2003). Hierarchical differentiation is one of the customs of police agencies; police ranks have for many decades been maintained as they were instituted. Therefore, I made use of the number of ranks as obtained from Maguire.

### **Adoption of Innovation (Dependent Variable)**

#### **Adoption of Digital Forensics Practice**

Police agencies deal with crime-related problems by establishing specialized task units in various degrees to address the problems in their jurisdictions. Langworthy (1986) pointed out the distinction of various police practices as "specialized tasks" rather than expert individuals (p. 67). The LEMAS-2003 survey addressed the variation of police practices with four different questions: (a) whether the agency has a specialized unit with full-time personnel to address this problem/task, (b) whether the agency has dedicated personnel to address this problem/task, (c)

whether the agency addresses this problem/task, but does not have dedicated personnel, and (d) whether the agency does not address this problem/task. The information concerning functional differentiation in police agencies was gathered from the LEMAS-2003 surveys. LEMAS includes this question for 22 problems/tasks. I used the question regarding cybercrime units as of the dependent variable in order to see how local police agencies respond to digital evidence.

Adopting from Dewar & Dutton (1986), I recoded adoption of digital forensics practice as shown in Table 5: 3 indicating major technological advances, 2 representing an improvement over existing technology, 1 (I added this option as another layer to explain adoption) denoting *minor* improvement over existing technology, and 0 standing for no new knowledge contained in the machine or process. Further research could be done on the dependent variable. The limitations and justifications about using the dependent variable as in the current study are explained in the next chapters' limitations section.

Table 5: Radicalness of Adoption of Innovation

Theoretical degree of adoption of innovation	Digital Forensics Practice Adoption	Code
Represented <i>a major</i> technological advance	Agency has specialized unit with full-time personnel to address this problem/task.	3
Represented <i>an improvement</i> over existing technology	Agency has dedicated personnel to address this problem/task.	2
Represented <i>minor</i> improvement over existing technology	Agency addresses this problem/task, but does not have dedicated personnel.	1
Had <i>no new knowledge</i> contained in the machine or process	Agency does not address this problem/task.	0

*Note.* This table is adapted from Dewar & Dutton (1986)

## The Hypothesized Structural Equation Model

Figure 8 shows the hypothesized structural equation model, which consists of the constructs already mentioned in the current chapter. Based on statistical analysis, the model will be validated using structural equation modeling.

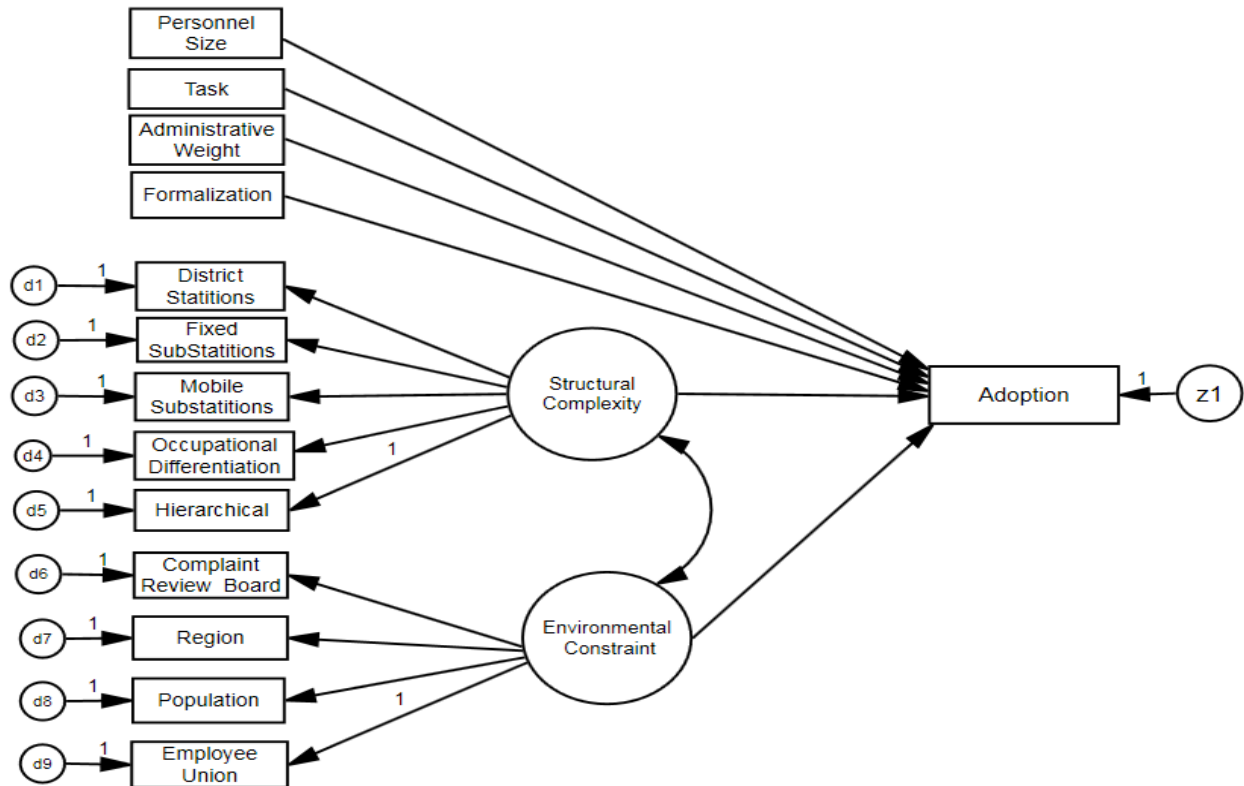


Figure 8: Structural Equation Model

## Statistical Modeling

### Structural Equation Modeling

The present study performs multivariate statistical modeling. Multivariate modeling is basically known as a way of determining the interrelatedness between and within sets of variables (Harlow, 2005). Multivariate analysis has been known as an important breakthrough to analyze organizations statistically (Wan, 2002). The use of structural equation modeling (SEM) has become increasingly significant in social science (Anderson & Gerbing, 1988) to apply

multivariate analysis. SEM provided a causal explanation of statistical processes with a series of structural equations, and these processes are modeled by using graphical tools (Byrne, 2001). The model consists of “multiple indicators for each variable (called latent variables or factors), and paths specified connecting the latent variables” (Garson, 2008, para 6).

SEM's substantive ability to assess and remodel theoretical models have drawn in many scholars using SEM as a statistical tool (Anderson & Gerbing, 1988). Older multivariate methods did not include confirmatory analysis as inclusive as SEM, which made it harder to test the hypothesis. SEM is advantageous in terms of providing exclusive methods to assess and correct measurement error. Older methods did not consider error(s) when processing explanatory variables in statistical methods. Another advantage of using SEM is that it provides a platform to test both latent and observed variables simultaneously (Byrne, 2001). SEM also allows the comparison of multiple samples while utilizing the same measurement tools (Schumacker, & Lomax, 1996).

This study applied the two basics of structural equation modeling, “validating the measurement model and fitting the structural model” (Garson, 2008, para 7). First, confirmatory factor analysis was used for validating the measurement model for the latent constructs. Factor analysis was applied to confirm which series of observed variables “share common variance-covariance characteristics that define theoretical constructs or factors (latent variables)” (Schumacker & Lomax, 2004, p. 168). Second, in a further analysis, structural equation modeling was used to develop a structural model that established equations among the latent variables (Schumacker & Lomax, 2004, p. 196).

## **Model Specification**

Researchers use model specification in order to create a theoretical model that confirms the relation of indicator variables with the concepts (latent constructs) and also how they fit collectively. In a given model specification, observable variables are indirect measures of latent constructs (Wan, 2002). Basically, model specification is about discovering the association between variables and also the parameters sought by the researcher (Schumacker & Lomax, 2004).

## **Tools**

PASW Statistics and AMOS 18 (Analysis of Moment Structures) as a statistical package were used due to their easy-to-use structural equation modeling (SEM) software (SPSS, 2011).

## **Statistical Criteria**

The measurement of the statistical significance level (P) for the present study was set to 0.05. The reliability of survey instruments was tested using Cronbach's alpha ( $\alpha$ ) for all scales, as an extra measure though confirmatory factor analysis presents greater strength in assessing measurement models. Moreover, the correlation matrix was applied to test multicollinearity between the independent variables. The normality test was done for all variables before performing further statistical analysis with any of the variables included in the study..

**Hypothesis Testing:** In contrast to conventional statistical theory testing, which aims to reject the null hypothesis, SEM leans toward not rejecting  $H_0$  (Byrne, 2001). Specifically, the sample converiance matrix should be same as or very close to the theoretical covariance model (Schumacker, & Lomax, 2004). Hence, a high p value denotes that there is no difference between the observed model and anticipated model.

**Standardized structural (path) coefficients:** Path coefficients indicate the relative degree of indicators on the latent construct (Garson, 2011).

**Model fit statistical criteria:** Statistical criteria of the structural equation model are indicated in Table 6.

Table 6: Model Fit Statistical Criteria

Goodness-of-Fit Indices	Criterion
Chi-Square ( $\chi^2$ )	Lower
Probability (P)	$\geq .05$
Degree of freedom (df)	$\geq 0$
Likelihood Ratio ( $\chi/df$ )	$< 5$
Goodness of Fit Index (GFI)	.95
Adjusted GFI (AGFI)	$> .90$
Tucker Lewis Index (TLI)	$> .90$
Normed Fit Index (NFI)	$> .90$
Root Mean Square Error of Approximation	$\leq .05$
Hoelter's Critical N (CN)	$> 200$

## CHAPTER VI: FINDINGS

### Descriptive Analysis

First, the univariate analysis of each study variable including their minimum-maximum values, standard error, and relative tendency is described. Second, the bivariate relations between each variable are measured in order to describe their strength of relation.

#### **Contextual Variables**

Key constituents of policing have been related to contextual variables. It is important to describe and understand univariate statistics concerning the contextual variables that this study focuses on, that is, the number of sworn police officers and task scope of police agencies.

*The number of sworn police officers* in police agencies has been considered a significant capacity indicator of police agencies to enforce law. Needless to say, police agencies cannot practice policing without having a sufficient number of sworn officers. For example, as we look at the LEMAS-2003 Survey, we see that there are police agencies with 0 personnel. Further investigation reveals that those agencies' municipalities contract for law enforcement services with another municipal police agency or county sheriff's office that is close to their jurisdiction.

According to the descriptive results of Table 7, the standard error for the number of actual paid sworn officers with arrest power was high enough to increase skewness and kurtosis out of the normal range (+2,-2). Thus, outlier cases, which are cities that have exceedingly high number of officers due to their extremely large populations and service area, were excluded. This helped remove the extreme cases but was not enough to solve the normality problem. In order to normalize the dataset, square root transformation of the variable was performed. Taking directly the square root of the variable did not cause any problem because the objective of this study was

to work with municipal police agencies that have 100 or more officers, which means none of them included 0 and 1.

The following table indicates that the minimum number of actual paid sworn police officers in a given agency for this study was 100, while the maximum number of sworn police officers in a given agency was 2,943. The mode of number of sworn officers was 155, which indicates the most frequently appearing number of employed officers in police agencies. The median of employed sworn officers was 185, which indicates that half the police agencies in this study employed more than 185 officers and vice versa. The average number of sworn officers that police agencies employed was 320. *Task scope* has been considered as one of the major determinants of production in organizations. I chose only law-enforcement-related items from the LEMAS-2003 survey to establish an additive index concerning their task scope because I expected more consistency related to major functions of policing practices by police agencies.

The descriptive results of the task scope variable indicated that the distribution of this variable was slightly skewed. No data transformation for task scope was made. According to Table 7, police agencies employ at least 8 different law enforcement functions and investigative tasks, while the maximum number of tasks employed by a given police agency is 39. Standard deviation is at normal range, which indicates, by looking at a histogram of task variation, a steep variation around the mean and a lower variation around the edges of the histogram.



Table 7: Descriptive Analysis of Contextual Variables

N=345	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
Actual Paid Sworn Officers	100	2943	320.05	19.229	357.162
Task Scope	8.00	31.00	21.4464	.18362	3.41051

Note. N = Number of cases

### Environmental Constraints

Environmental constraint is an important concept that has come under the scrutiny of most sociological studies. The present study analyzed LEMAS-2003 data to determine how environmental constraints influence specialization and the adoption of innovation.

Looking at the minimum and maximum values in Table 8 concerning partnership and population reveals that the standard deviations of both variables were very high. This situation led to testing the normality of those variables. After normality testing, both partnership union and population data came out positively skewed, as expected. To deal with this problem, square root to normalize data distribution was performed.

*Partnership with unions or groups* have been considered important indicators of environmental constraint for organizations. However, a thorough test of its impact on police agencies and adoption of innovation could bring more insight for understanding the degree to which they are important. The following table indicates a standard deviation that is not very high.

According to the succeeding table, police agencies in this study had at least one partnership with unions or employee groups. The average number of partnerships with organizations with which police agencies have contact was 5.5, while the maximum was 9. More

than 21% of police agencies have a partnership with at least nine organizations that interact with the police agency concerning problem-solving issues. In contrast, 19% of agencies have only one partnership with unions or social groups.

*Population* is considered a major determinant of environment and thus environmental constraint. Most factors that influence police agencies' organizational behavior are part of population, which creates constraints and pressures on police organizations. Due to high standard error and also large skewness, the study applied square root transformation to normalize the data set, which resulted in normal distribution. The following table indicates that the minimum population a given police agency in this study was responsible for was 24,691, while the maximum population was 1,214,725. The average population for a given police agency's jurisdiction was 153,611. The percentile scores indicated that more than 50% of the police agencies had fewer than 101,972 people in their jurisdiction, while 5% of them had over 471,008 citizens in their jurisdiction.

*Regional location* has been thought of a good indicator of development in the United States. Many organizational scholars have asserted the importance of the western region regarding police organizations. In the present study, cities in the western region are coded as 1 and others as 0. Table 8 indicates that 25 % of police agencies are located in the western region of the U.S. while the rest are located in other regions of America.

Table 8: Frequency Table for Regional Location

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	257	74.5	74.5	74.5
1	88	25.5	25.5	100.0
Total	345	100.0	100.0	

*Citizen complaint review boards* have been seen as an important indicator that discloses information about problems related to police agencies, and they have also been seen as an indirect way for citizens to be involved in the decision making of police agencies. LEMAS-2003 involved a dichotomous variable inquiring whether civilian complaint review boards were empowered to review citizen complaints. The standard deviation of the variable was minor. According to the frequency data, 81.4% of the police agencies did not have a civilian complaint review board in their jurisdiction to review officers' use of force against civilians. Because only 18.6% of the study's police agencies had at least one complaint review board in their jurisdiction, a question arises about the openness of police agencies to boards or other agencies in reviewing their use of force.

Table 9: Descriptive Analysis of Environmental Variables

	Minimum	Maximum	Mean	Std. Deviation
Partnership	1.00	9.00	5.000	2.984
Region	0	1	.255	.436
Population	24691	1214725	153611	155074.149
Complaint Review Board	0	1	.19	.389

### Structural Control

*Administrative weight* was considered to be the relative size of administrative personnel in police agencies. Because there was no normalization problem with the data, data

transformation was not employed. According to the descriptive statistics of Table 10, the minimum administrative weight for municipal police agencies was .04, while the maximum administrative weight was .45. According to the administrative weight histogram, the steepness shows that most data were clustered between .18 and .30. This range indicates police agencies' tendencies toward the weight of their administration. The mean of administrative weight was .24 with a very low standard error.

*Centralization* indicates the level of participation at a given organization. Lower centralization means more participation and sharing of decision making. The following table indicates that the minimum centralization was 30 and maximum centralization was 75. According to the percentiles statistics, one half of police agencies in the sample had 49 or less centralization. Only 25% of agencies were centralized as 53 and over.

*Formalization*, in this study, was considered to be police directives of police agencies under written policy specifications. The degree of formalization has been an important variable in understanding formal police agencies.

Because formalization had only one missing value, it was replaced with the median of formalization. As we look at the following table, the minimum formalization value was 10 while the maximum value of formalization was 25 and the mean value of formalization was 16. Standard deviation and skewness were small for the formalization variable; therefore, there was no need for data transformation. . The mode of formalization was 17, and according to percentile statistics, 50% of municipal police agencies' formalization value was 17 or under 17.

Table 10: Descriptive Analysis of Structural Control Variables

	Minimum	Maximum	Mean	Std. Deviation
Formalization	10	25	16.40	1.609
Admin. Weight	.04	.45	.236	.074
Centralization	30	75	48.63	7.829

### **Structural Complexity**

Police agencies divide their responsibilities into the following differentiating factors: hierarchical differentiation, occupational differentiation, district stations differentiation, fixed neighborhood substation differentiation, and mobile neighborhood substation differentiation. The following section parses the descriptive statistics related to structural complexity.

#### *Hierarchical Differentiation*

As only three hierarchical values were missing, they were replaced with the mean of the variables, which did not make an important difference in the new mean and standard deviation. According to Table 11, the standard deviation and skewness and kurtosis of data were at the acceptable range, which led to normal distribution concerning hierarchical distribution. The minimum number of ranks that police agencies had was 4, which was implemented by only very minor percentage (1.2%) of municipal police agencies. The most frequent segmentation in police agencies was 6, which was implemented by 41% of agencies; the second most frequently employed rank segmentation was 5, implemented by 34.5% of municipal police agencies.

Table 11: Frequency Distribution of Hierarchy

	Frequency	Percent	Cumulative Percent
Valid 4	4	1.2	1.2
5	119	34.5	35.7
6	159	46.1	81.7
7	53	15.4	97.1
8	9	2.6	99.7
9	1	.3	100.0
Total	345	100.0	

*Occupational Differentiation* is considered to be the ratio of civilians to sworn officers. Four missing variables were replaced with the mean score as they were less than 5%. Data imputation did not make an important difference in mean and standard deviation or in the normal distribution of data. The minimum ratio of civilians to sworn officers was .31, while the maximum ratio was .899. The mean score of occupational differentiation was .317. Most data points were between 0.1 -0.5, which indicates that most police agencies employed relatively fewer civilians than the data clustered between 0.5 and 1.

*Spatial Differentiation* was explained with three different variables in LEMAS-2003: district/precinct/division stations, fixed neighborhood substations, and mobile neighborhood substations. Because there were no missing values, no imputations were made. As the three spatial differentiation variables' kurtosis values were large, square root transformation was applied to each of them. The transformation helped reduce the standard errors of the variables, which were very large.

There were municipal police agencies with no district stations or substations. The maximum number of district stations managed by a municipal police agency was 17, the

maximum number of fixed neighborhood Substation was 48, and the maximum number of mobile neighborhood substations was 4.

Table 12: Descriptive Analysis of Structural Complexity Variables

	Minimum	Maximum	Mean	Std. Deviation
Hierarchical Differentiation	4	9	5.85	.808
Occupational Different.	.02	.90	.31	.147
District Stations	0	17	1.53	2.497
Fixed Neighborhood	.0	48	2.66	4.541
Mobile Neighborhood	0	4	.28	.631

**Degree of Adoption of Digital Forensics Practice (Dependent Variable)**

According to Table 13, 24% of local police agencies that were included in the present studies` sample had a specialized unit with full-time personnel to address digital forensics practice, and 37% of the local police agencies only had dedicated personnel to address the problem. Table 13 indicates that 32.8% of the police agencies addressed the problem but did not have dedicated personnel, and 5% of local police agencies did not address the problem.

Table 13: Frequency Table of Adoption of Innovation

	Frequency	Percent	Cumulative Percent
(1) Agency has specialized unit w f/t personnel to address problem	84	24.3	24.3
(2) Agency has dedicated personnel to address this problem	130	37.7	62.0
(3) Agency addresses this problem but doesn't have dedicated personnel	113	32.8	94.8
(4) Agency does not address this problem	18	5.2	100.0
<b>Total</b>	<b>345</b>	<b>100.0</b>	

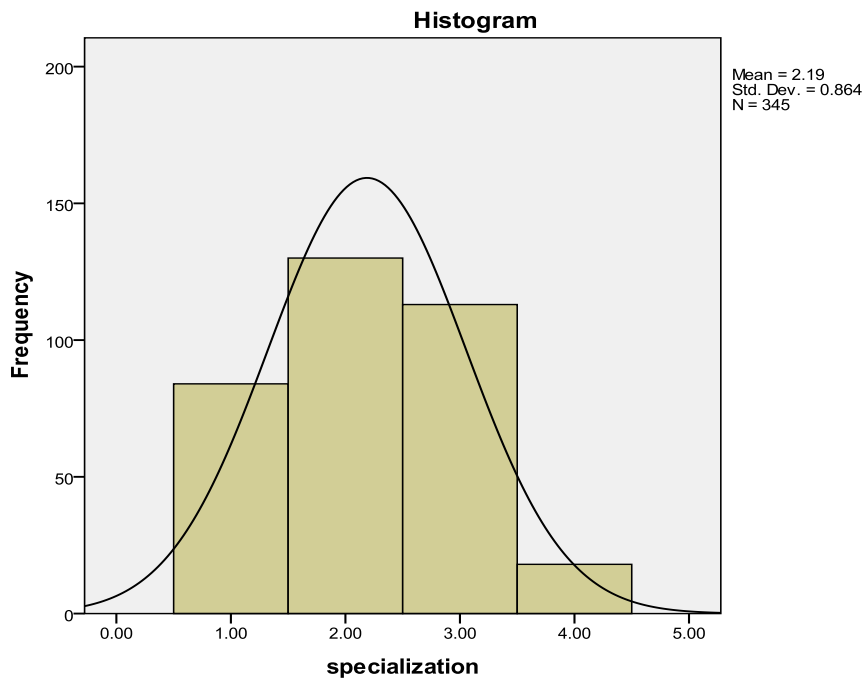


Figure 9: Frequency of adoption of innovation in municipal police agencies.



The above figure shows that most police agencies had dedicated personnel to deal with digital evidence or address the problem in varying methods. About a quarter of the agencies had adopted specialized units to deal with digital evidence. These descriptive statistics indicate that the police agencies in this study responded to digital evidence in most cases, while 5.2% of them did not address digital evidence under any condition.

### **Correlations and Multicollinearity**

Greasley (2008) stated that correlation helps statistician determine the direction and significance of the relation between two interval variables. Considering correlation, multicollinearity means a strong correlation exists between indicator variables. Riahi-Belkaoui (2000) defined multicollinearity as the strong relation of independent variables in a given regression coefficient. Multicollinearity exists when the independent variable's standard errors are very large and are intertwined. Byrne (2001) stated that multicollinearity also causes a nonpositive definite matrix.

Hensher, Rose & Greene (2005) mentioned that in order to test multicollinearity either bivariate or pairwise correlation is used to determine whether correlation is a reason of obstruction for model estimation. Usually statisticians consider 0.8 the cutoff point to indicate multicollinearity. This study used the Pearson correlation coefficient to determine the strength of relation between independent variables and their multicolliniarity.

Burns & Grove (2005) stated that multicollinearity does not influence the predictive power of independent variables on the dependent variable. For example, Maguire (2003) found multicollinearity between organizational size and environmental dispersion when he did not trim

outliers and also retained both of the variables. The present studies' tendency was to keep those variables with multicollinearity due to their importance in the literature and predictive power.

### **Environmental Constraint**

According to the correlation matrix of environmental constraint on the following table, partnership was correlated (0.125) with the presence of a complaint review board at the 0.05 level and also related with (0.166) population at the 0.01 level. There was also a positive correlation (0.148) between the presence of a complaint review board and region at the 0.01 level and correlation (.385) between the presence of a complaint review board and population. Region is also correlated with population at the 0.01 level. The highest correlation (0.385) appeared to be between the presence of a complaint review board and population, while the second highest correlation (0.223) appeared to be between population and region. All of the Pearson correlations indicate no multicollinearity or strong correlation between any of the variables, as none of the correlations are close to the indicated threshold.

Table 14: Correlation Matrix for the Analysis of Environmental Variables

		Partnership	Civilian Complaint Review Board	Region	Population
Partnership	Pearson Correlation Sig. (2-tailed)	1			
Civilian Complaint Review Board	Pearson Correlation Sig. (2-tailed)	.125*	1		
Region	Pearson Correlation Sig. (2-tailed)	.033	.148**	1	
Population	Pearson Correlation Sig. (2-tailed) N	.166**	.385**	.223**	1 5

Note. \*. Correlation is significant at the 0.05 level (2-tailed).

\*\* . Correlation is significant at the 0.01 level (2-tailed).

### Structural Control

Table 15 indicates the existence of a significant relation (-.136\*) at the 0.05 level only between administrative weight and centralization. Therefore, the data indicate that the lower the centralization (more participation), the higher the administrative weight. This might be due to the importance assigned to administration in terms of its relative size to all staff members, and its participation with lower-ranking officers. Considering all the variables` correlations between each other, no correlation is close to our threshold (0.8), which indicates that there is no need to worry about the multicollinearity of variables.

Table 15: Correlation Matrix for the Analysis of Structural Control Variables

		Formalization	Administrative Weight	Centralization
Formalization	Pearson Correlation	1		
	Sig. (2-tailed)			
Administrative weight	Pearson Correlation	.087	1	
	Sig. (2-tailed)	.105		
Centralization	Pearson Correlation	.092	-.136*	1
	Sig. (2-tailed)	.089	.012	

Note. \* Correlation is significant at the 0.05 level (2-tailed).

### Contextual Factors

The following table indicates no significant relationship between personnel size and task in large local police agencies. Moreover the data indicates no multicollinearity problem between the variables as their correlation is not over the specified threshold 0.8.

Table 16: Correlation Matrix of Contextual Variables

		Task	Staff
Task	Pearson Correlation	1	
	Sig. (2-tailed)		
Personnel Size	Pearson Correlation	.033	1
	Sig. (2-tailed)	.537	

It is highly possible that the number of personnel and population in the environment of local police agencies are highly correlated. It would be a straightforward and expected explanation for coefficients changing signs once both variables are in the structural equation

model. According to Table 17, the relationship between the sworn personnel and population size in the environment of large local police agencies are highly correlated and the correlation is over 0.8.

Table 17: Correlation Matrix between Staff and Population

		Staff	Population
Staff	Pearson Correlation	1	
	Sig. (2-tailed)		
Population	Pearson Correlation	.891**	1
	Sig. (2-tailed)	.000	

*Note.* \*\*. Correlation is significant at the 0.01 level (2-tailed).

For this undesirable situation, the methodological literature was reviewed. Wan (2003) explained this situation as the distortion effect. He stated that “a distorter variable is a third variable that converts the observed relation between two variables so that it diverges from the real one” (p. 58). Wan further noted that when a third variable Z is introduced to the structural equation, it may confound the equation between X and Y, which consequentially turn the hypothesized relation of the two variable into a negative one. The high colliniarity problem between the number of personnel and population is considered in the structural equation model. Additional analysis of the structural equation model resulted in the fact that the Population variable distorts the Number of Police Agency Staff variable and turns its relation with Adoption of Digital Forensics Practice into a negative one. As police agency size has been considered a significant element of organizational studies, the present study retains it in the structural equation model

## Structural Complexity

The following table indicates that district stations was correlated with (.291) fixed neighborhood substations at the 0.01 level, and correlated with (.117) mobile neighborhood substations at the 0.05 level, and also correlated with (.339) hierarchical differentiation at the 0.01 level—the highest correlation among all correlations. Second, fixed substations was correlated with (.142) mobile neighborhood substations at the 0.01 level, and also correlated with (.185<sup>\*\*</sup>) hierarchical differentiation at the 0.01 level. Because all correlations were lower than the indicated threshold, multicollinearity regarding any of the variables indicated on Table 12 cannot be claimed.

Table 18: Correlation Matrix for the Analysis of Structural Complexity Variables

		District Stations	Fixed Substations	Mobile Substations	Occup. Different.	Hierarch. Different.
District Stations	Pearson Correlation	1				
	Sig. (2-tailed)					
Fixed Substations	Pearson Correlation	.294 <sup>**</sup>	1			
	Sig. (2-tailed)	.000				
Mobile Substations	Pearson Correlation	.117 <sup>*</sup>	.142 <sup>**</sup>	1		
	Sig. (2-tailed)	.029	.008			
Occupational Differentiation	Pearson Correlation	-.035	.069	-.008	1	
	Sig. (2-tailed)	.515	.201	.883		
Hierarchical Differentiation	Pearson Correlation	.339 <sup>**</sup>	.185 <sup>**</sup>	.057	-.083	1
	Sig. (2-tailed)	.000	.001	.294	.122	
	N	345	345	345	345	345

*Note.* \*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

Above, the possibility of collinearity only within each factor was assessed. Because it is possible that measures across factors are collinear, each factors` collinearity is assessed and high

collinearity is found only between personnel size and population, which is mentioned in the above section in this chapter. The correlation tables across factors can be found in the appendix.

### **Confirmatory Factor Analysis**

According to Wan (2002), inferential statistics is a way of making a conclusion by selecting a study unit with a certain size of sample to generalize the outcomes of a study to bigger populations. Wan stated that the confirmatory approach utilizes comparatively small sets of data out of a population and relies on the literature or previous studies` methodology or outcomes. Using these inputs, confirmatory factor analysis (CFA) helps in building a prototypical measurement model from a selected number of the indicators that have shared a common variance of one or more theoretical constructs. The following section includes measurement models that explain the degree to which and typology with which theoretical constructs are measured by manifest or observed variables.

### **Environmental Constraint**

Environmental constraint was measured with four manifest variables: complaint review board, region, population, and employee unions. Each variable constituted the scale of their measurement except for region. Region was coded as a dichotomous variable, indicating 1 for municipal police agencies that are located in the western region of the United States and 0 for the agencies located in other regions of the United States. In order to validate our measurement model, the incorporation of manifest variables on environmental constraint CFA was measured.

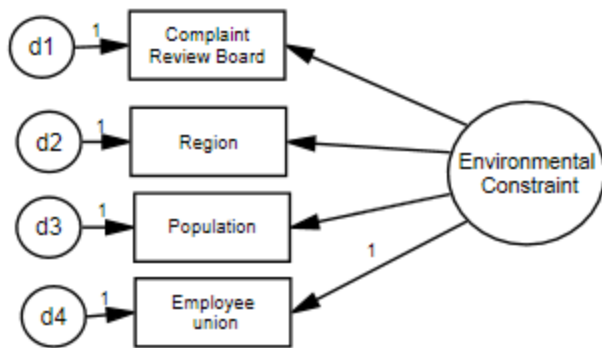


Figure 10: Measurement model of environmental constraints.

Based on the statistical analysis, the critical ratio of all variables in Table 13 was higher than  $\pm 1.96$  ( $CR \geq \pm 1.96$ ), which means all regression weights were significant at least at the .05 level.

Table 19: Parameter Estimates of Environmental Constraint Variables

		Estimate	S.E.	C.R.	P
Partnership	<--- Environment C.	.241			
Population	<--- Environment C.	.845	.493	2.892	.004
Region	<--- Environment C.	.312	.245	3.142	.002
Complaint Review B.	<--- Environment C.	.453	.283	3.524	***

The following table represents the goodness-of-fit measures of the current model. According to Table 20, all conventional cutoff values were met, which means the current model fit well enough with the hypothesized model. Specifically, the p-value shown in Table 17 confirms the hypothesized model. Furthermore, the likelihood ratio (.44) was less than 5, which also means this measurement model's fitness is acceptable.



Table 20: Goodness-of-Fit Measures for Environmental Constraint

Goodness-of-Fit Indices	Criterion	Structural Model
Chi-Square ( $\chi$ )	Lower	.880
Probability (P)	$\geq .05$	.644
Degree of freedom (df)	$\geq 0$	2
Likelihood Ratio ( $\chi/df$ )	$< 5$	.440
Goodness of Fit Index (GFI)	$> .90$	.999
Adjusted GFI (AGFI)	$> .90$	.994
Tucker Lewis Index (TLI)	$> .90$	1.037
Normed Fit Index (NFI)	$> .90$	.991
Root Mean Square Error of Approximation	$\leq .05$	.000
Hoelter's Critical N (CN)	$> 200$	2343

### Structural Control

Although Maguire (2003) and Wilson (2006) treated administrative weight, formalization, and centralization under the same construct, these three indicators are not enough to identify the model concerning the data set of LEMAS-2003. The number of parameters is not enough to identify the model. The centralization variable was dropped from the model as it was unidentified and older than other variables. The formalization and administrative ratio were treated in the structural equation model individually to measure their impact on the dependent variable.

### Structural Complexity

Using CFA, this study measured the structural complexity of organizations, district/precinct/division stations, fixed neighborhood substations, mobile neighborhood substations, and hierarchical differentiation. Occupational differentiation was removed from the model as it did not load on the factor significantly.

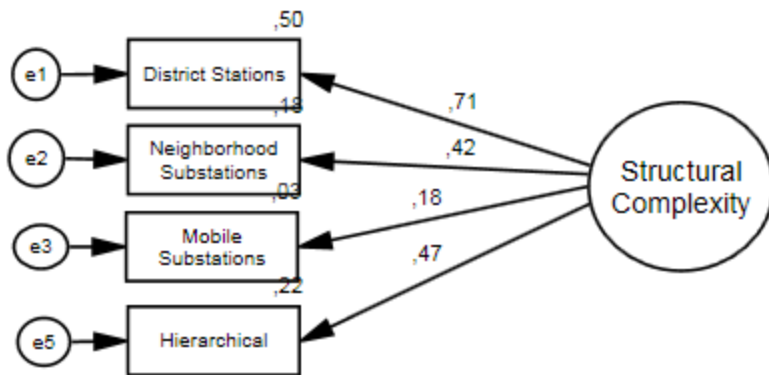


Figure 11: Measurement Model of Structural Complexity

Table 21 indicates that the critical ratios of all variables were in the acceptable range ( $CR \geq \pm 1.96$ ). According to the regression weights of each variable indicated in Table 18, factor loadings were significantly related to their latent construct. Factor loadings at higher levels indicate a good convergent validity of the variables on the latent construct.

Table 21: Regression Weights of Structural Complexity Variables

			Estimate	S.E.	C.R.	P
Hierarchical D.	<---	Complex	1.000			
District Stations	<---	Complex	.71	.045	3.916	.014
Neighborhood S.	<---	Complex	.42	.202	4.617	***
Mobile Stations	<---	Complex	.18	.300	2.465	***

### Regression Weights: (Group number 1 - Default model)

All the goodness-of-fit measures confirmed the hypothesized model. The p value (.299) and the likelihood ratio (1.207) indicated that they stand by their related criteria. RMSEA was below the criterion ( $\leq .025$ ), while GFI, AGFI, TLI and NFI were slightly over the specified criterion (.90), as shown in Table 22.

The following scale items indicate the goodness-of-fit measures concerning the structural complexity of municipal police agencies.

Table 22: Goodness-of-Fit Measures for Structural Complexity

Goodness-of-Fit Indices	Criterion	Structural Model
Chi-Square ( $\chi$ )	Lower	2.4
Probability (P)	$\geq .05$	.299
Degree of freedom	$\geq 0$	2
Likelihood Ratio ( $\chi/df$ )	$< 5$	1.207
Goodness of Fit Index (GFI)	$> .90$	.996
Adjusted GFI (AGFI)	$> .90$	.982
Tucker Lewis Index (TLI)	$> .90$	.984
Normed Fit Index (NFI)	$> .90$	.972
Root Mean Square Error of Approximation (RMSEA)	$\leq .05$	0.025
Hoelter's Critical N (CN)	$> 200$	518

### **Reliability**

Garson (2011) indicated that in a given measurement model, Cronbach's alpha for indicators should have a value of .7 or higher to claim reliability. The Cronbach's alpha value for environmental constraint was .4. The calculated value of Cronbach's alpha for structural complexity was .4 as well. Therefore, it appears that Cronbach's alpha for both environmental constraint and structural complexity were lower than the threshold. However, as Garson (2011) mentioned, on some occasions several fit indices in CFA are higher than expected, yet the Cronbach's alpha is lower than the threshold. Garson noted that fewer manifest variables in the scale could result in a lower Cronbach's alpha. The present study relied on confirmatory factor analysis to measure the reliability of measurement models, yet the results of the Cronbach's alpha are briefly mentioned.

### **Structural Equation Model**

Previously, confirmatory factor analysis was performed to validate the measurement models concerning the exogenous latent constructs. This section examines how each exogenous construct could explain the total variation in an endogenous variable or construct. The latent exogenous variables of the study were structural complexity and environmental constraints, as indicated in Figure 13. Other predictors include observed variables such as personnel size, task scope, administrative weight, and formalization of the police agency. The endogenous variable of the SEM model was the adoption of innovation, which scaled the degree to which large municipal police agencies address digital forensics practice at the organizational level.

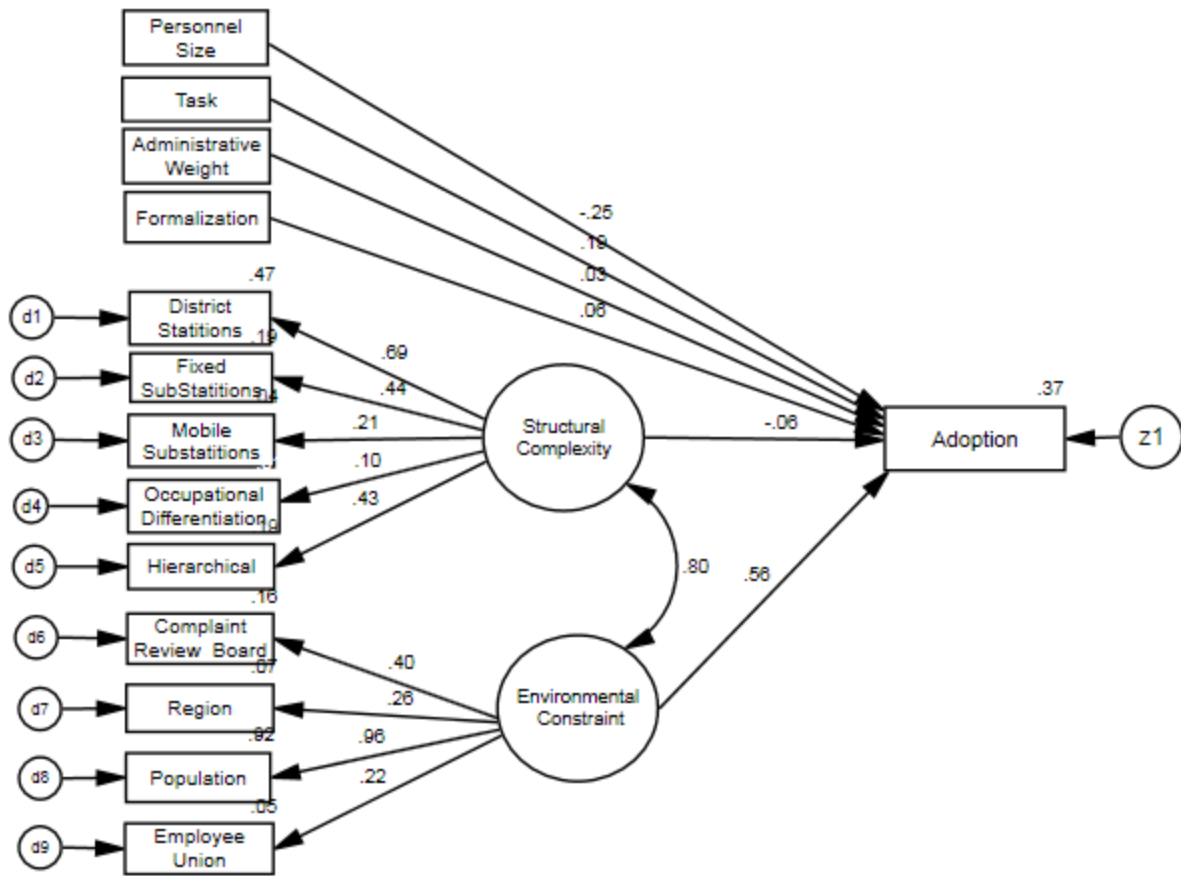


Figure 12: Generic Structural Equation Model

The generic model represented in Figure 15 does not validate the hypothesized model according to goodness-of-fit measures. The chi-square value (1064.082) is high, the probability level is less than .05 (0), the likelihood ratio is greater than 5 (14.188), the goodness-of-fit index is lower than >.90 and other measures in Table 23 do not support the hypothesized model.

Table 23: Goodness-of-Fit Measures for Structural Equation Model

Goodness of Fit Indices	Criterion	Structural Model	Revised Structural Model
Chi-Square ( $\chi$ )	Lower	1064.082	941.638
Probability (P)	$\geq .05$	.0	.0
Degree of freedom	$\geq 0$	75	73
Likelihood Ratio ( $\chi/df$ )	$< 4$	14.188	12.899
Goodness of Fit Index (GFI)	$> .90$	.783	.817
Adjusted GFI (AGFI)	$> .90$	.696	.737
Tucker Lewis Index (TLI)	$> .90$	.115	.202
Normed Fit Index (NFI)	$> .90$	.265	.350
Root Mean Square Error of Approximation (RMSEA)	$\leq .05$	.196	.186
Hoelter's Critical N (CN)	$> 200$	32	35

Because the generic model was not validated, statistical values on modification indices table were analyzed in order to improve the structural model. The analysis of Table 24 correlates the error term d7 with the d4 and d5 error terms. Correlating d7 and d1 did not seem to improve the revised model; therefore, no correlation was added between d7 and d1.

Table 24: Modification Indices

	M.I.	Par Change
d7 <--> d4	75.153	.029
d7 <--> d1	6.124	-.029
d7 <--> d5	40.588	-.109

The revised structural model improved the structural equation model, though not significantly. The difference between the generic and revised SEM's chi-square value was 122.444. The difference of the degree of freedom of the two models (-2), and also the difference between the two model's likelihood ratio (1.289) is insignificant. To sum up, the revised model

resulted in a poor fit with the model, though the test results still revealed important correlations concerning the endogenous variable and several of its indicators.

### Revised Structural Model

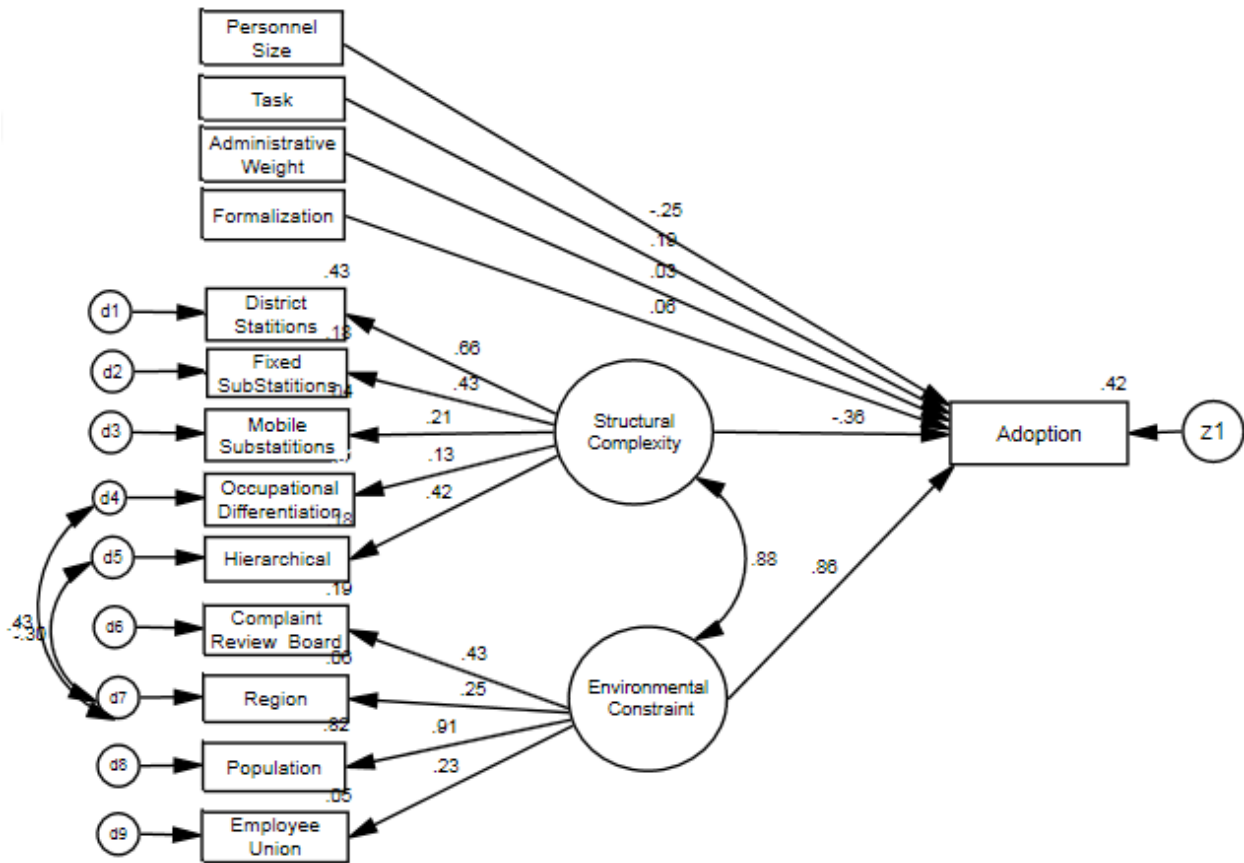


Figure 13: Revised Structural Equation Model

The following table indicates that the administrative weight, formalization, and structural complexity have no significant influence on the adoption of digital forensics practice given their p values, which are higher than .05. Nonetheless, removing them from the structural equation model did not significantly improve the revised model.

Environmental constraint, task, and number of personnel in large local police agencies have a significant influence on adoption of innovation. According to Table 25, the number of

personnel has a negative relationship with adoption of digital forensics practice. This is due to the distortion effect already discussed in the multicollinearity section of the present study.

Among all of the indicators of adoption of innovation, environmental constraint has the highest regression weight (.856). Structural complexity with regression weight -.357 and with the p value .361 has no significant impact on the adoption of innovation. Considering the coefficient of determination ( $R^2$ ), all indicator variables included in the following table account for .42 of the variance in the adoption of digital forensics practice by large municipal police agencies.

Table 25: Standardized Regression Weights

Variables	Generic Model				Revised Model			
	S.R.W.	S.E.	C.R.	P	S.R.W.	S.E.	C.R.	P
Population <--- Environment	.961	.472	3.784	***	.907	.402	3.955	***
Mobile S. <--- Complexity	.205	.044	3.051	.002	.206	.045	3.074	.002
Adoption <--- Complexity	-.064	.490	-.363	.717	-.357	1.131	-.914	.361
Fixed S. <--- Complexity	.436	.196	5.323	***	.426	.203	5.220	***
District S. <--- Complexity	.688	.190	6.452	***	.659	.193	6.318	***
Region <--- Environment	.261	.230	3.085	.002	.248	.206	3.019	.003
Complaint <--- Environment	.404	.274	3.575	***	.433	.269	3.679	***
Ranks98 <--- Complex	.432				.418			
Union <--- Environment	.219				.232			
Occupation <--- Complexity	.098	.027	1.542	.123	.131	.028	2.065	.039
Adoption <--- Environment	.564	1.261	2.721	.007	.856	2.404	2.034	.042
Adoption <--- Formal	.061	.026	1.392	.164	.057	.026	1.315	.189
Adoption <--- Admin W.	.026	.573	.607	.544	.029	.571	.668	.504
Adoption <--- task	.187	.012	4.304	***	.188	.012	4.317	***
Adoption <--- personnel	-.254	.138	-5.841	***	-.250	.138	-5.729	***

Note: SRW=Standardized Regression Weight; S.E = Standard Error C.R. = Critical Ratio P= Significance Value

\*\*\* = correlation is significant at  $p < 0.001$



## **Hypothesis Testing**

**H<sub>1</sub>:** Environmental constraints positively influence police agencies' degree of adoption on digital forensics practice.

This hypothesis was confirmed with the high regression weight (.856) on the adoption of digital forensics practice. Therefore, according to inferences made from the structural equation modeling, it is sensible to claim that environmental constraints positively influence the adoption of digital forensics practice. To sum up, the stronger the environmental constraints, the greater the extent of adoption of digital forensic practice or innovation.

**H<sub>2</sub>:** While formalization and administrative weight negatively influence the degree of adoption of innovation, task and personnel size positively influence the degree of adoption of digital forensics practice.

Formalization and administrative weight have no statistically significant influence on adoption of innovation. . SEM analysis also reveals that task positively influences the adoption of innovation, while personnel size negatively influences the adoption of innovation at a significant level. The negative correlation between the dependent variable and the number of personnel was unexpected. This problem is addressed in the multicollinearity section of the study.

**H<sub>3</sub>:** Police organizational complexity positively influences the degree of adoption of digital forensics practice by large local police agencies.

Based on the statistical analysis, organizational structural complexity negatively influences the adoption of digital forensics practice, though the correlation is not statistically significant.

## CHAPTER VII: CONCLUSION

### Summary of Findings

#### **Adoption of Digital Forensics Practice**

Although not exactly evenly distributed, the degree of adoption of digital forensics practice varies by agency. The large local police agencies in this study had assigned dedicated personnel to respond to cybercrimes at a rate of 37.7%, while 32.8% of them only addressed the problem. Only 24.3% of local police agencies had specialized units with full-time personnel. The police agencies that did not address digital evidence in any way consisted of 5% of all agencies included in the sample.

According to the radicalness index adopted from Dewar & Dutton (1986), the majority of police agencies showed *an improvement* over existing technologies of their agencies. Less than one third of large local police agencies showed a *minor* improvement over their existing technologies. About a quarter of them showed a *major* technological advance, which is considered to be the most radical point for large local police agencies in the adoption of digital forensics practice. The analysis revealed that approximately 5% of large local police agencies have *no new knowledge contained* in machines or process regarding digital forensics practice.

Having a specialized unit with full-time personnel is a good indicator of responding to digital evidence; these units include personnel, devices to investigate cybercrime and obtain digital evidence, and enough space to keep backlogs in storage. However, fewer than one quarter of police agencies in the sample had responded to digital evidence with specialized units. This may initially suggest that the rest of the agencies in the sample were inadequate in dealing with digital evidence. However, just as it is possible to deal with gang problem without establishing a

gang unit to a certain degree, it is also possible to deal with digital evidence to a certain degree without establishing a cybercrime unit. Additional research should be done to understand the efficiency and effectiveness of responding to digital evidence in varying degrees.

While it is hard to know what exactly has driven police agencies to adopt the practice at different levels, the present study statistically explains the variation in terms of the adoption of digital forensics practice by .42%. The following section discusses the indicators of adoption of digital forensics practice.

### **Adoption of Digital Forensics Practice and Environmental Constraints**

Crank (2003) states that “police agencies are exemplars of institutionalized organizations” (p. 187). Although Crank’s assertion has been confirmed by many organizational studies in the criminal justice field, the factors that influence institutionalization are subject to change across time. Therefore, the factors influencing organizations in varying processes should have been examined empirically.

According to Scott (2008), “diffusion of an institutional form across space” has a tremendous impact on the potency of an institutional structure (p.132). The present study specifically examined the adoption of digital forensics practice by local police agencies across the United States while examining the spread of digital forensics practice from an institutional view.

The institutional factors influencing organizations are usually located in the environment in which values, norms, and beliefs are constructions of social structure. The environment is expected to influence police agencies to conform to the forces of environment. As the

institutional environment endows rights, police agencies are expected to adopt professional practices based on cognition that are constituted by normative institutional pressures.

It was initially hypothesized that environmental constraints were likely to significantly influence the adoption of digital forensics practice in a positive direction. The institutional features of environment could be so strong that they lead to the establishment of police practices in varying degrees.

Statistical analysis indicates that a significant relation exists between adoption of innovation and environmental constraints. Environmental constraints with the path coefficient .856 positively influence the adoption of digital forensics practice. The analysis indicates that the higher the level of environmental constraints, the higher the levels of adoption of digital forensics practice in police agencies.

Environmental constraints have the greatest impact on digital forensics practice as compared to other predictors of adoption of innovation. Because environmental constraints were utilized in lights of institutional theory, the impact of institutional factors exceeds the influences of organizational factors that are related to the internal features of police agencies. Among all the indicators of environmental constraints, size of the population, the presence of a citizen complaint review board, regional location, and partnership have consistently strong regression weights on environmental constraints.

### **Adoption of Digital Forensics Practice and Contextual Factors**

The contextual factors included in this study were personnel size and task. It was initially postulated that size positively influences police agencies` adoption of digital forensics practice. According to the results of the present structural equation model, the personnel size of the police

agency negatively influences specialization. The negative influence of personnel size on the adoption of innovation was unexpected and discussed in the collinearity section of the study. According to structural equation model, the relationship between the two variables significant. The present study retain their significance though claim that their relationship is positive. The initial expectation for the impact of task on the adoption of innovation was positive. The expectation was confirmed. Higher task scope in a given large local police agency creates a more significant potential for adopting digital forensics practice. This finding suggests that police agencies that adopt more varied tasks to deal with crime are also more likely to be interested in dealing with digital evidence.

#### **Adoption of Digital Forensics Practice and Structural Coordination and Control Factors**

The arrangement of organizations has always been held responsible for the activities of organizations in the public eye. When things go wrong unexpectedly, the control of organizations is usually first in line to be questioned. Nonetheless, the criminal justice literature has not given enough evidence about the impact of organizational control on various activities held in police agencies.

It was initially suggested that administrative weight could influence the adoption of digital forensics practice negatively. Nonetheless, the study found that this variable has no significant influence on the adoption of digital forensics practice. In addition, the standard regression weight of administrative weight was .03, which was the lowest factor loading in the structural model. Therefore, a negative influence of structural control factors on the adoption of digital forensics practice could not be confirmed.

Formalization has been considered an obstacle to innovation by many organizational scholars. Based on statistical analysis, the degree to which formalization is applied at local police agencies does not explain the variation in the degree of adoption of digital forensics practice.

### **Adoption of Digital Forensics Practice and Structural Complexity**

It was postulated that structural complexity could impact adoption innovation positively. However, the path coefficient shows an insignificant impact. In order to further inquire into this surprising finding, the latent construct *environmental constraints* were removed from the structural equation model. However, the insignificant influence of structural complexity on the adoption of digital forensics practice remains. The following variables are associated with structural complexity: district stations, fixed neighborhood substation, hierarchical differentiation, mobile neighborhood substation, and occupational differentiation. In particular, the first three variables listed play a significant role in measuring the complexity of police agencies. For example, as the number of district stations goes up in a given police agency, the agency's complexity increases significantly.

### **Environmental Constraints and Structural Complexity**

The statistical analysis confirms that environmental constraints and structural complexity are positively correlated. As environmental constraints increase by 1 standard deviation, structural complexity increases by 88%. The statistical analysis reveals how environmental constraint is important in terms of structural complexity. Moreover, contingency theorists have claimed that the internal functioning of police agencies should comply with environmental factors. As a result, the present studies' finding complies with the contingency theorists' findings.

### **Policy Implications**

As Cooper and Zmud (1990) stated, organizations' current situation compels these organizations to make their "operational, tactical, and strategic processes" more effectual (p. 123). According to Elmore (1979), policy making could be more influential if it complies with the applicability of adoptions. This study conceived the degree of adoption as one of the most important components of organizations because adoption was expected to comply with organizational features and environmental constraints. Describing the variance in terms of the adoption of digital forensics practice will help assess the trend in police agencies in regard to dealing digital evidence. Moreover, understanding what causes particular types of adoptions in police agencies will offer an opportunity to discuss the adoption of innovations on an empirical basis. Finding such information may eventually help policy makers to improve the current situation in police agencies based on empirical analysis.

### **Implications of Environmental Constraint**

Historically, criminologists have considered environment an important aspect of understanding crime. Similarly, adoption of special practices has been considered an essential means of understanding the way police agencies respond to crime at the organizational level. The present study utilized the institutional perspective to understand the impact of environmental constraints on the adoption of digital forensics practice.

As stated before, institutionalization is usually based on powerful myths and expectations that are outside the bounds of rationality. Based on the statistical analysis in this study, the high impact of environmental constraints indicates that institutional factors supersede the importance

of organizational control of police agencies. Therefore, the efficiency and effectiveness of the digital forensics practices established should be a matter of critical concern.

The minimum cost for training an individual specialized in digital forensics practice is about \$8,000 at the initial stage. In addition, the high costs of forensic equipment and software increase the importance of investment in the adoption of digital forensic practice. For example, addressing digital forensics practice but having only a few cybercrime cases in a police agency's jurisdiction could be a waste of time and resources. On the other side, insufficient investment on digital forensic practice by police departments could result in large backlogs or unexpected results due to insufficient training of forensic experts.

### **Implications of Structural Complexity**

Structural complexity is one of the most sought-after issues of organizational research; the impact of complexity on other variables has been analyzed to a significant extent. Researchers have usually considered the complexity of organizations to be correlated with the adoption of special practices. Nonetheless, the present study surprisingly did not find that structural complexity had a significant impact on the adoption of innovation. The statistical analyses indicate that large local police agencies adopt digital forensics practice at varying degrees regardless of the organizations' structural complexity. As it appears that police agencies are more concerned with their environment than their structural control, the reason for their lack of concern about the internal functioning of their agencies when responding to digital evidence merits future research.



### **Implications of Contextual Factors**

The statistical analysis reveals that police agencies consider the number of personnel that they allocate for the agency when they decide to establish digital forensics practice at higher levels. This is a somewhat expected result, as digital forensics practice is processed by individuals, which means having more personnel to employ offers more opportunities to assign personnel for new adoptions.

Because task variation is significantly associated with the adoption of digital forensics practice, the capacity of police agencies to deal with a larger number of tasks in the agency indicates the agency's capacity to adopt new practices. Therefore, policy makers could focus on and further support those police agencies with higher task variation to facilitate the adoption of digital forensics practice, as these agencies seem more adaptive to different tasks.

### **Implications of Structural Control and Coordination Factors**

Administrative weight does not have any significant influence on the adoption of innovation. This finding supports Wilson's (2006) findings. Similarly, Maguire did not find any significant impact of administrative weight on any organizational complexity variables. Based on the present study results and other major studies' results, it is fair to suggest that the administrative weight of police agencies does not directly influence the adoption of digital forensics practice by large local police agencies.

Although Wilson (2006) was expecting that formalization would have a negative impact on COP implementation, he found a positive relation between COP implementation and formalization. Maguire (2003) did not find any significant impact of formalization on any of the structural complexity and control variables. The present study did not find any significant impact

of formalization on the adoption of digital forensics practice. The varying results of different studies indicate that future research should address the causal influence of organizational formalization on the adoption of innovation.

### **Contribution of the Study**

The present study considered degree of adoption of digital forensics practice as a dependent variable to investigate how organizational variables may influence the variation in adoption of digital forensics practice. Treating adoption of digital forensics practice as a dependent variable contributes to the literature because digital evidence is an increasing concern of today`s law enforcement agencies. As digital forensics practice is one of the most recent adoptions of police agencies, it is important to understand what factors drive police agencies to adopt digital forensics practice.

The present study utilized three different theoretical perspectives to evaluate different factors influencing the variability in the adoption of digital forensics practice. Identifying several concepts under the rubric of different theoretical perspectives helped compare the past theoretical approaches` findings with the present studies` results from varying angles. As Wan (2002) stated, "Observations are always interpreted in the context of prior knowledge" (p. 4).

Furthermore, the present study could inspire policy makers to discuss the response to digital forensics practice on an empirical basis rather than relying on recent mythologies of cybercrime. Equally important, the present study is one of the first studies to utilize multivariate statistics to evaluate digital forensics practice at the organizational level. Using confirmatory factor analysis helped determine how well the observable variables come together to measure the

latent constructs of the present study. In addition, using structural equation modeling helped identify how constructs are structurally or causally related with each other.

### **Limitations**

Due to the researcher's time limitations, the adoption of digital forensics practice was not measured broadly. A self-employed survey that captured the intensity and extensiveness of digital forensics practices used in local police departments could have enhanced the measurement of the dependent variable.

Measuring adoption of innovation by a single variable is not a perfect approach because its validity could not be adequately demonstrated in terms of construct and predictive validity. However, as we delve into the content of adoption of innovation at the organizational level, such an approach denotes more information than it initially appears. Adoption of digital forensics practice at the organizational level is an outcome variable that includes varying properties and activities of digital forensics practice.

The present study did not address adoption of digital forensics practice in sheriffs' departments. Determining the causal relation between organizational factors and the adoption of digital forensics practice by county sheriffs' departments could lead to understanding of the differential impacts of county and municipal governance in responding to digital evidence.

The focus of this study was large local police agencies. Therefore, small police agencies were excluded from the analysis. However, their small chance of adopting digital forensics practice prevented the researcher from spending further time and effort on differently sized of local police agencies.

The present study cannot not be over-generalized to address all sorts of adoption of innovation in police agencies. To do so, several types of innovations should be considered. For example, King (1998) analyzed 10 different innovations as adopted by local police agencies. Because the present study focuses on only one type of innovation, it is hard to claim that all types of police innovations are exposed to the same types of interactions with organizational variables. As Chamard (2003) stated, different innovations diffuse in different ways (p. 171).

The use of secondary data has certain limitations, such as data timing and developing operational definitions of measurable constructs or concepts. Although using secondary data seems disadvantageous, LEMAS is reliable and the only nationally collected dataset concerning law enforcement agencies. Moreover, many researchers have used LEMAS for various purposes for many years.

This study utilized cross-sectional design—that is, police agencies’ organizational design based on the LEMAS survey conducted in 2003. The utilization of longitudinal data could have improved the explanations about the cause-and-effect relations of the study variables.

Because this is a cross-sectional study, the exposure of law enforcement agencies to varying organizational factors at different times could not be measured. The study mainly reveals conditions that are observed at a specific time point. For example, the impact of environment at different times could be measured using longitudinal data and analysis. Without applying a longitudinal study, it is not possible to claim that the variability in the adoption of digital forensics practice is attributable to the preexistence of environmental constraints and organizational factors.

The structural equation model did not fit as expected though for many scholars, including Garson (2008) & Wan (2003); model fit does not indicate the strength of relationships between variables. The generic model was improved with the revised model; nonetheless, the generic model did not allow much space to improve the structural equation model. This problem could be dealt with by considering more variables based on the relevant literature or purposing a better designed model.

### **Validity**

The present study addressed convergent and discriminant validity by using confirmatory factor analysis. Schumacker & Lomax (2004) mentioned that confirmatory factor analysis helps in finding convergent and discriminant validity. According to Garson (2011), convergent validity is proven when all observable variables are associated significantly. Goodness-of-fit indices and also structural path coefficients delineate the convergent validity of measurement models. In the confirmatory factor analysis, the present study relied on both goodness-of-fit indices and pattern coefficients to confirm the convergent validity of measurement models.

Gefen & Straub (2005) stated that discriminant validity is proven when every one of the indicators in the measurement model are imperceptibly associated with all other constructs except for the hypothesized one. This study is based on the CFA, which relies primarily on prior studies' methods to address certain constructs and then tests the hypothesis statistically. Therefore, the relations between indicators and constructs are tested statistically, and it is also confirmed that they are not significantly related with other constructs.

### **Future Studies**

This study analyzed the adoption of digital forensics practice with one manifest variable. More robust research is needed to improve the measurement of digital forensics practice adoption by large local police agencies. The activities included in digital forensics practice may vary. Organizational studies of the criminal justice system have largely focused on other types of innovations, including crime mapping, gang units, and problem-oriented policing. This study offers a rare example of research on digital forensics practice. More research on different aspects of digital forensics practice is needed in the future, with an emphasis on the determinants of digital forensics practice and standards of operating digital forensic investigation units.

For example, the internal features of digital forensics units could be surveyed in terms of the number of personnel that they assign for the unit, whether the agency receive grant/funding from other institutions or resources to adopt digital forensics practice, or the ratio of digital forensics investigations that were conducted by the unit or practitioner in the past year concerning the crimes committed against computer.

One of the major findings of the present study is the importance of environmental constraints in large local police agencies. Environments evolve, and more factors connect with the environment that could constrain police agencies for varying reasons. For example, social networking could be considered part of environmental constraints. Social networking on a website could change the view of police agency towards digital forensics practice. Twitter and Facebook have become large facilitators of information sharing and gathering for community meetings and political purposes. Community organization concerning local matters on social networking web sites should be analyzed as another factor that constrains police agencies.

The institutional environments of organizations are fragmented and conflicted (Scott, 2008). Therefore, considering each concept as if uniform could delimit the contentions of empirical research. According to the present study's results, population is an important indicator of environmental constraint. More research on the content of population, specifically the heterogeneity/homogeneity of the population, should be conducted. Other variables that could be useful to analyze are: educational differentiation, income differentiation, and race heterogeneity. For example, the level of education in different parts of the population might influence the willingness to see professional practices by police agencies. Specific fragments of the population with higher education level might be more interested in professional response of police agencies to digital evidence. Income level in varying parts of society might influence the way citizens appreciate police practices. People with a higher income level might want their tax dollars invested on high-tech law enforcement practices. The influence of race heterogeneity should be analyzed because different ethnicities with different values and norms might approach police practices differently.

One of the unexpected results of the study was the finding of an insignificant relation between structural complexity and adoption of innovation. More variables should be added to identify structural complexity. Information technology that is broadly used in local police agencies could impact the degree to which structural complexity is implemented.

Future studies could implement the following strategies to tolerate the weaknesses of the sampling frame in the present study: (1) select geographical areas first and then (2) select equal number of police departments.

Further research is needed to understand the lack of significant impact that police agencies' structural complexity has on the adoption of digital forensics practice. Moreover, rigorous research on more parameters related with organizational control is needed.



## **APPENDIX A: LOG TRANSFORMATION TABLES**

Table 26: Log Transformation of Spatial Differentiation Variables

	V38	V39	V_40	V_38 (sqrt)	V_39 (sqrt)	V_40 (sqrt)
N Valid	345	345	345	345	345	345
Missing	0	0	0	0	0	0
Skewness	2,717	1,589	4,963	2,008	2,992	2,356
Std. Error of Skewness	,131	,131	,131	,131	,131	,131
Kurtosis	9,560	2,569	37,249	6,790	10,807	5,833
Std. Error of Kurtosis	,262	,262	,262	,262	,262	,262

*Note.* v38 = district/precinct/division stations v39 = fixed neighborhood/community stations v40=mobile neighborhood/community stations.

Table 27: Log Transformation of Actual Paid Sworn Personnel

	Staff	Staff_logged
N Valid	345	345
Missing	0	0
Skewness	3,462	1,123
Std. Error of Skewness	,131	,131
Kurtosis	15,060	,835
Std. Error of Kurtosis	,262	,262

*Note.* \* Actual paid sworn with arrest f/t

Table 28: Partnership Square Rooted

	Partnership	Partn_sqrt
N Valid	345	345
Missing	0	0
Skewness	,038	-,273
Std. Error of Skewness	,131	,131
Kurtosis	-1,468	-1,345
Std. Error of Kurtosis	,262	,262

Table 29: Log Transformation of Population

		Pop	pop_logged
N	Valid	345	345
	Missing	0	0
Skewness		3,372	,834
Std. Error of Skewness		,131	,131
Kurtosis		15,022	,683
Std. Error of Kurtosis		,262	,262

## **APPENDIX B: CORRELATION MATRIX**

Table 30: Correlation Matrix for Each Variable

		<b>Administrative Ratio</b>	<b>Complaint Review B.</b>	<b>Formalization</b>	<b>Occupational Differentiation</b>
Administrative Ratio	Pearson Correlation	1			
	Sig. (2-tailed)				
Complaint Review Board	Pearson Correlation	.076	1		
	Sig. (2-tailed)	.157			
Formalization	Pearson Correlation	.087	.130*	1	
	Sig. (2-tailed)	.105	.016		
Occupational Differentiation	Pearson Correlation	.493**	.051	.090	1
	Sig. (2-tailed)	.000	.344	.095	
Population	Pearson Correlation	.215**	.380**	.128*	.167**
Hierarchical Differentiation	Pearson Correlation	.095	.248**	.140**	-.083
Region	Pearson Correlation	.230**	.148**	.018	.480**
	Sig. (2-tailed)	.000	.006	.742	.000
Adoption	Pearson Correlation	.079	.139**	.103	.028
	Sig. (2-tailed)	.145	.010	.055	.604
Personnel	Pearson Correlation	.207**	.431**	.176**	.139**

		<b>Administrative Ratio</b>	<b>Complaint Review B.</b>	<b>Formalization</b>	<b>Occupational Differentiation</b>
	Sig. (2-tailed)	.000	.000	.001	.010
Task	Pearson Correlation	-.094	.067	.036	.058
	Sig. (2-tailed)	.083	.217	.501	.283
Union	Pearson Correlation	.056	.125*	.159**	.095
	Sig. (2-tailed)	.297	.021	.003	.077
District Stations	Pearson Correlation	.113*	.232**	.122*	-.035
	Sig. (2-tailed)	.036	.000	.023	.515
Fixed Substations	Pearson Correlation	.013	.241**	.101	.069
	Sig. (2-tailed)	.813	.000	.061	.201
Mobile Substations	Pearson Correlation	-.021	.116*	.079	-.008
	Sig. (2-tailed)	.692	.032	.143	.883
	N	345	345	345	345

Table 31: Correlation Matrix for Each Variable Continued

		<b>Population</b>	<b>Hierarchical Differentiation</b>	<b>Region</b>	<b>Adoption</b>	<b>Staff</b>
Admin. Ratio	Pearson	.215**	.095	.230**	.079	.207**
	Correlation					
	Sig. (2-tailed)	.000	.078	.000	.145	.000
Civilian Complaint Review Board	Pearson	.380**	.248**	.148**	.139**	.431**
	Correlation					
	Sig. (2-tailed)	.000	.000	.006	.010	.000
Formalization	Pearson	.128*	.140**	.018	.103	.176**
	Correlation					
	Sig. (2-tailed)	.017	.009	.742	.055	.001
Occupational Differentiation	Pearson	.167**	-.083	.480**	.028	.139**
	Correlation					
	Sig. (2-tailed)	.002	.122	.000	.604	.010
Population	Pearson	1	.319**	.266**	.319**	.891**
	Correlation					
	Sig. (2-tailed)		.000	.000	.000	.000
Hierarchical Differentiation	Pearson	.319**	1	-.243**	.050	.461**
	Correlation					
	Sig. (2-tailed)	.000		.000	.354	.000
Region	Pearson	.266**	-.243**	1	.128*	.074
	Correlation					
	Sig. (2-tailed)	.000	.000		.018	.168

		<b>Population</b>	<b>Hierarchical</b>	<b>Region</b>	<b>Adoption</b>	<b>Staff</b>
			<b>Differentiation</b>			
Adoption	Pearson	.319**	.050	.128*	1	
	Correlation					
	Sig. (2-tailed)	.000	.354	.018		
Staff	Pearson	.891**	.461**	.074	.237**	1
	Correlation					
	Sig. (2-tailed)	.000	.000	.168	.000	
Task	Pearson	.019	-.013	-.102	.214**	.033
	Correlation					
	Sig. (2-tailed)	.727	.810	.058	.000	.537
Union	Pearson	.205**	.105	.033	.185**	.207**
	Correlation					
	Sig. (2-tailed)	.000	.052	.542	.001	.000
District Stations	Pearson	.532**	.339**	-.002	.165**	.617**
	Correlation					
	Sig. (2-tailed)	.000	.000	.973	.002	.000
Fixed Substations	Pearson	.333**	.185**	-.024	.097	.386**
	Correlation					
	Sig. (2-tailed)	.000	.001	.663	.072	.000
Mobile Substations	Pearson	.171**	.057	.000	-.047	.177**
	Correlation					
	Sig. (2-tailed)	.001	.294	.994	.384	.001
	N	345	345	345	345	345



Table 32: Correlation Matrix for Each Variable Continued (2)

		<b>Task</b>	<b>Union</b>	<b>District Stations</b>	<b>Fixed Sub- Stations</b>	<b>Mobile Sub- stations</b>
Administrative Ratio	Pearson	-.094	.056	.113*	.013	-.021
	Correlation					
	Sig. (2-tailed)	.083	.297	.036	.813	.692
Civilian Complaint Review Board	Pearson	.067	.125*	.232**	.241**	.116*
	Correlation					
	Sig. (2-tailed)	.217	.021	.000	.000	.032
Formalization	Pearson	.036	.159**	.122*	.101	.079
	Correlation					
	Sig. (2-tailed)	.501	.003	.023	.061	.143
Occupational Differentiation	Pearson	.058	.095	-.035	.069	-.008
	Correlation					
	Sig. (2-tailed)	.283	.077	.515	.201	.883
Population	Pearson	.019	.205**	.532**	.333**	.171**
	Correlation					
	Sig. (2-tailed)	.727	.000	.000	.000	.001
Hierarchical Differentiation	Pearson	-.013	.105	.339**	.185**	.057
	Correlation					
	Sig. (2-tailed)	.810	.052	.000	.001	.294
Region	Pearson	-.102	.033	-.002	-.024	.000
	Correlation					
	Sig. (2-tailed)	.058	.542	.973	.663	.994
Adoption	Pearson	.214**	.185**	.165**	.097	-.047
	Correlation					
	Sig. (2-tailed)	.000	.001	.002	.072	.384
Staff	Pearson	.033	.207**	.617**	.386**	.177**
	Correlation					
	Sig. (2-tailed)	.537	.000	.000	.000	.001
Task	Pearson	1	.148**	.018	.021	.091
	Correlation					
	Sig. (2-tailed)		.006	.744	.698	.091
Union	Pearson	.148**	1	.094	.087	.068
	Correlation					

	Sig. (2-tailed)	.006		.081	.109	.210
District Stations	Pearson	.018	.094	1	.294**	.117*
	Correlation					
	Sig. (2-tailed)	.744	.081		.000	.029
	N	345	345	345	345	345
Fixed Substations	Pearson	.021	.087	.294**	1	.142**
	Correlation					
	Sig. (2-tailed)	.698	.109	.000		.008
Mobile Substations	Pearson	.091	.068	.117*	.142**	1
	Correlation					
	Sig. (2-tailed)	.091	.210	.029	.008	

## **APPENDIX C: DATA SOURCE**

Table 33: Data Source

Variable	Attribute	Question	Source	LEMAS-Questions
<b>Environmental Constraint</b>	Latent Exogenous Variable			
Partnership	Exogenous	<b>Q 31</b> During the 12-month period ending June 30, 2003, did your agency have a problem-solving partnership or written agreement with <b>any of the following?</b> (Additive)	LEMAS-2003	V209-218
Citizen (Complaint) Review Boards	Exogenous	59a. Is there a civilian complaint review board/agency in your jurisdiction that is empowered to review use of force complaints against officers in your agency? YES/NO	LEMAS-2003	V462
Regional Location	Exogenous	Which region is the police agency located?	Self-collection	
Number of sworn officers	Exogenous	Q3.a Sworn personnel with general arrest powers * authorized full-time paid positions	LEMAS-2003	V42
Task Scope	Exogenous	Q1. Which of the following functions did your agency have PRIMARY responsibility for or perform on a regular basis during the 12-month period ending?	LEMAS-2003	V1-37

<b>Variable</b>	<b>Attribute</b>	<b>Question</b>	<b>Source</b>	<b>LEMAS- Questions</b>
<b>Structural Complexity</b>	Latent Exogenous Variable			
Spatial differentiation	Exogenous	2. Enter the number of facilities or sites, SEPARATE FROM HEADQUARTERS, operated by your agency as of June 30, 2003.	LEMAS-2003	V38-39-40
Occupational differentiation	Exogenous	3. Enter the number of AUTHORIZED FULL-TIME paid agency positions and ACTUAL full-time and part-time paid agency employees	LEMAS-2003	V42-V48
Hierarchical Differentiation	Exogenous	Number of ranks	<b>Maguire (98 data)</b>	
<b>Control Factors Below</b>				
Formalization	Latent Exogenous Variable	56. Does your agency have written policy directives on the following?	LEMAS-2003	V438-453
Administrative Weight	Latent Exogenous Variable		LEMAS-1999	Total full time emp=v171+v17 3
Population	Latent Exogenous Variable	2003 Population	LEMAS-2003	pop
<b>Adoption of Innovation</b>	<b>Endogenous</b>	<b>27. How does your agency address the following problems/tasks?</b>	LEMAS-2003	

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