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THESIS

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Abstract

Street gangs have plagued the United States for decades. One focus of current gang prevention efforts strives to reduce the number of new recruits to local street gangs. This research proposes the uses of modeling and decision analysis to aid in identifying potentially "at risk" children likely to join a street gang in Montgomery County, Ohio. A stronger means of identification of "at risk" children can lead to a more efficient placement of resources to reduce the number of street gang recruits. The approach also aids in differentiating between neighborhoods to help focus efforts.

Information obtained from value-focused thinking (VFT) analysis is used to determine an allocation of six hypothetical gang prevention programs for an Ohio county. A notional knapsack analysis is performed to illustrate the potential notional percentage reduction of "at risk" children using the six hypothetical gang prevention programs within the seventeen cities in the county. Different notional scenarios are discussed and a notional scenario is recommended to demonstrate a potential use of the proposed model and operations research in general in the public sector areas.

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Bernard Jacob Loeffelholz

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I. Introduction

Background

Throughout the world, including the United States, gangs exist in all societies. Merriam-Webster (2007) defines a gang as a "group of persons having informal and usually close social relations." Merriam-Webster (2007) also gives a more modern definition of a gang as a "loosely organized group that controls a territory through readiness to use violence, especially against other gangs." There are many different types of gangs in existence such as street gangs, prison gangs, criminal gangs, political gangs, gangs based on religion, race, and many others (GATE, 2005). The focus of this thesis is identifying individuals likely to join a street gang.

Street gangs can be defined in many different ways, depending on an individual's views. One accepted definition for street gangs is "any durable, street-oriented youth group whose own identity includes involvement in illegal activity" (Klein, 2005:136). Pertaining to this definition, durable deals with those gangs that have lasting capacity in a particular area, avoiding the gangs that tend to collapse after a short time. Street-oriented does not have to be limited to the streets, but could be extended to parks, malls, schools, or other areas youth may gather. The issue of youth, in the last part of the definition, also requires clarification. This term can be extended anywhere from adolescents to those in their twenties. However, it is not unusual to find thirty-year-olds affiliated in street gangs (Klein, 2005).

Street gangs are of interest because the profile or model can be related to some areas of interest to the DoD more accurately than a profile of prison gangs or blood gangs. Prison or blood gangs profile differently because membership in the gangs are restrictive. Blood gangs must consist *only* of members who share similar blood lines. Membership into many prison gangs is only possible if the person is institutionalized or was institutionalized at one time. In prior research, there appears to be no definitive characteristics one must have to join a street gang (Klein, 2005). Some could argue that location or sex plays a role in joining a street gang; these issues are addressed further in this thesis. For the purpose of this thesis, an assumption is made that limited requirements exist to join a street gang.

Researching street gangs is an important issue due to the influence they have on the overall crime rate. "Gangs are no longer a problem limited to major city centers; their influence has contaminated the surrounding suburban areas and spread to rural communities" (NAGIA, 2005:14). Crime statistics are difficult to collect when discussing what percentage of the crime rate is attributed to activity done by street gangs. The Bureau of Justice (2005) has collected surveys over 11 years to obtain an idea of what percentage of violent crimes is attributed to gang members. These figures are given in Table 1.

Table 1. Percent of violent crimes attributed to gang members (Bureau of Justice, 2005)

Year	% Crimes commited by gang member
1993	8.6
1994	9.6
1995	8.3
1996	9.8
1997	7.2
1998	5.7
1999	5.9
2000	6.1
2001	4.8
2002	5.8
2003	5.8

According to the 2005 National Gang Threat Assessment, nearly 26 percent of law agencies in the United States had reported a positive association between street gangs and organized crime groups (NAGIA, 2005). These crimes can range from drug trafficking, money laundering, violent crimes, and frauds. Exact data is difficult to obtain on crime rates, but gang participation is prevalent in all areas of crime.

In the United States, only a small number (5.7 percent) of gang members are reported to be affiliated with terrorist groups, both domestic and international (NAGIA, 2005). Most of the affiliates are with the domestic terrorist groups and these groups are comprised mostly of white supremacists (NAGIA, 2005:5). A great deal of research has been done to find a link between American street gangs and international terrorist groups, but little has been discovered. One connection, between the Black P Stone Nation and the Libya government (in 1986), has been documented but other hypothesized connections potentially exist (NAGIA, 2005). Although there is a lack of evidence between street gangs and terrorist groups, this thesis contends that the two groups tend to attract similar candidates for membership.

Specific attraction to a gang can and does vary by individuals and gangs. Age, sex, creed, neighborhood and other defining characteristics can vary widely among gang participants. In addition, different social and economic factors play a role in one's desire or need to join a street gang.

"In the past, gang participation would have been confined to primarily a young boy's teens whereas, at present, participation may extend to age 30 and beyond" (Sanchez-Jankowski, 2003:206). It needs to be noted that a person of any age has the capability of joining a gang. Depending on the type of gang, the average age of the participating gang members may change. For example, members of a motorcycle gang might be older than those belonging to a juvenile detention gang. Sex and creed follow in the same manner as age and is explored in more depth later in the thesis.

Urbanization has often been suggested as the reason for gang formation. The increase in urbanization can be attributed to the number of immigrants entering the country. "Gangs did not originate in America" (Hagedorn, 2005:155). Rather, they have existed all over the world and have created "wherever industrialization and related processes drive people into cities" (Hagedorn, 2005:155). However, urbanization cannot be seen as the sole cause and location of street gangs as gangs exist in suburban and rural areas as well.

Income levels and job placement can have a large effect on those who join gangs. Youths tend to become upset when they are not likely to find jobs that can allow them to rise above the socio-economic level attained by their parents (Portes and Rumbaut, 2001). In hopes to avoid this situation, teenagers will turn to a gang that promises a way out of that life and higher payouts (Sanchez-Jankowski, 2003). Low-level income youths many

times want to help out their family during tough times and feel they may have no other alternative than to turn to a local gang.

Family influence can be another factor in joining a gang. Many gangs, such as the Mafia, follow the idea that the new child would soon take over the family business. Many times, these children are not shown any other way to live but that of the gang life (Sanchez-Jankowski, 2003). Dysfunctional families can also contribute to a teenager's desire to join a gang. This can be caused by problems with family members, especially being alienated from the parents. This alienation from the child may cause the parent not to realize their child is a part of a gang and feel there is nothing wrong in the child's life (Craig, Vitaro, Gagnon & Tremblay, 2002) or, sadly, care if there is something wrong in some cases.

Peer pressure is often the topic of discussion concerning the behavior of children and teenagers. A study performed by Craig *et al.* (2002) on adolescents showed that those who have friends that are members of a gang typically join a gang themselves. Past research has shown that aggressive children will become friends with other children who are similarly aggressive (Cairns & Cairns, 1991). Typically, children and teenagers feel the need for acceptance and joining groups can fulfill that need, regardless of economic status.

Drugs can play a critical role in the motivation to join a gang. "In the past, the Italian Mafia monopolized the drug industry, including controls over both production and distribution" (Sanchez-Jankowski, 2003:206). However, newer immigrants and other gangs slowly took control of the drug market; some because of the violence in the streets

and business while others due to the introduction of new drugs on the American market, such as cocaine (Sanchez-Jankowski, 2003).

The occurrence of gangs taking over the drug sales has attracted new members in two different ways. One reason for new membership is attributed to the illusion of an "endless" supply of drugs they can access at their disposal for being a part of the gang. The second attraction is the promise of large amount of profit to be made from producing and selling the drugs to contacts already made by the gang (Fagan, 1989).

Incarceration has a great effect on joining a gang. Prison gangs and street gangs have been considered separate entities in some studies, but as of late have become more associated with one another (Sanchez-Jankowski, 2003). In fact, many street gang members feel they will be arrested multiple times, therefore "will become members of prison gangs or make formal alliances with them" (Sanchez-Jankowski, 2003:207). This idea ties into reasons one may join a prison gang, and then later a street gang or vice versa. It can help offer protection from other inmates and also allows access to the drug market, from either the prisons or the streets (Sanchez-Jankowski, 2003).

The reasons, situations, and availability of joining a gang are all present in many communities, but how the attraction can be diminished is the focus of this study. Profiling is a tool that can be implemented to help reduce the numbers joining and also increase the numbers exiting gang life. Merriam-Webster (2007) defines profiling as the "act of suspecting or targeting a person on the basis of observed characteristics or behavior." Profiles can be created to help fully understand what kinds of persons join gangs and what reasons exist for their retention in gangs. Understanding the underlying

roots and causes for gang membership can lead to programs and laws to assist in reducing gang life in not only the United States, but the world as well.

Different types of profiling are in use today. The first type of profiling is known as "after the fact" profiling. This involves attempting to solve a crime that has already occurred using evidence or clues from the actual crime scene. This is also known as offender profiling when trying to "predict the characteristics of an offender based on information available at the crime scene" (Mokros and Alison, 2002:25). Eyewitnesses and DNA become important tools in trying to apprehend the criminal. Avid users of this type of profiling are crime scene detectives, forensic scientists, and the police (Bumgarner, 2002).

Grouping is another type of profiling in use. Racial profiling is a dominant category of grouping. Racial profiling is "any use of race, religion, ethnicity, or national origin by law enforcement agents as a means of deciding who should be investigated, except where these characteristics are part of a specific suspect description" (Angulo & Weich, 2002:11). Angulo and Weich assert that racial profiling makes the assumption, which is statistically incorrect, that most criminals in the United States are minorities (2002). Grouping can also group people together based on affiliation, work status, or other social and economics factors.

Major weaknesses with racial profiling can be issues of discrimination and inaccuracy (Innes, 2003). However, strengths have been documented by the use of racial profiling. El Al, an airline based out of Israel, has established a reputation for implementing effective security measures even thought they may be controversial (Walt, 2001; Madsen, 1997). As racial profiling has been proven useful as well as destructive, if

abused, a balance or cost-benefit assessment coupled with extensive education and training needs to be developed before implementing this particular use of profiling (Risse & Zeckhauser, 2004).

Problem Statement

Different types of gangs exist in the United States and around the world. Reasons and characteristics of those who join gangs can and do differ between people. The focus of this research is on the reasons and characteristics of those who join domestic street gangs. The definition of street gangs used in this thesis is "individual members, gang cliques, or entire gang organizations that traffic drugs; commit shootings, assaults, robbery, extortion, and other felonies; and terrorize neighborhoods" (Johnson, Webster, & Connors, 1995:2). Research on this subject in this study primarily focuses on formation of street gangs in the United States, but can be extended to other gangs or formation of terrorist groups. This thesis examines different underlying causes as to who joins gangs and why these new members joined. Understanding and modeling the different causes and reasons will assist the government to develop a working profile on gang recruits and allow governments to establish laws or programs to deter the growth and formation of gangs.

Problem Approach

This research effort develops a working profile of the reasons individuals join street gangs. This profile will be referred to as the gang model and explicitly defines characteristics, background, social, economic and any other factor involved with individuals joining a street gang. The behavioral model developed is specific to street gangs but attempts to relate the model to terrorist group formation will be administered.

Data from gang researching organizations can also be used to examine the reasons individuals have for joining gangs. Different techniques such as multivariate analysis, which includes cluster analysis and discriminant analysis, are effective in interpreting the data. Another technique could fall under the category of social network models and use ideas of cohesion to measure formation and actions of groups. This can include uni-dimensional and multi-dimensional models (Cota, Evans, Dion, Kilik, and Longman, 1995). These models will not be demonstrated in this thesis but rather another approach to investigate this problem will be the use of value-focused thinking.

After the profile was constructed, one way this information will be used is in an Ishikawa (fishbone) diagram. The Ishikawa diagram assists the reader and user in clearly identifying different aspects or underlying causes for joining a gang. The use of the diagram is non-numerical but provides an overview of elements of how to stop the formation and growth of gangs and gang members. The development and implementation of the Ishikawa diagram is detailed in Chapter 3 of this thesis.

The information developed in the Ishikawa diagram was used to feed further modeling efforts. This effort, used primarily in Decision Analysis, is known as value focused thinking (VFT). VFT assists in scoring individuals to aid in determining who is most "at risk," based on a scale of 0 to 1, to join a gang. The development and implementation of VFT is further developed in Chapter 3 of this thesis.

Research Scope

This thesis focuses its efforts on street gangs while the DoD is primarily interested in defense efforts but it is also concerned with non-domestic civilian issues as

well. The thesis also relies on the background from Psychology, Sociology, and Operations Research.

Street gangs are the primary focus on this research. This does not diminish the importance of other types of gangs, such as prison, motorcycle, and many others. Studying street gangs allows for the greatest variation in its members since membership is not limited to specific characteristics.

One limitation in this research is the access to data. Limited data exists on those joining street gangs and some of it is classified and therefore not able to be accessed for public use. Crime rates due to gangs are also hard to measure based on the limited knowledge of who is actually in a gang and if the crime was committed to benefit the gang. Much research has been done hypothesizing on why individuals join gangs, but no one has (at least publicly) presented a model for those who join gangs.

Overview and Format

The remainder of the thesis is organized as followed: Chapter 2 establishes an academic foundation behind the concepts of gangs, profiling, and terrorist groups. Different topics cover street gangs, gang members, terrorist groups, profiling, and possible models to implement. Chapter 3 develops an Ishikawa diagram based on joining a gang. All aspects of the model will be explained in great detail for the reader and user to understand. Once the model is constructed, its information was used to feed another model developed using VFT. The VFT model identifies potentially "at risk" individuals likely to join a street gang. Chapter 4 provides the results of the analysis outlined in Chapter 3. Finally, chapter 5 concludes the thesis and provides recommendation for future research.

II. Literature Review

Overview

There has been a great deal of research done on the areas of street gangs and profiling. However, street gangs still exist; in some cases stronger than they have been in the past. Deterring children from joining street gangs is an ongoing struggle for police, investigators, psychologists, and many other professionals. Many articles and studies address particular indicators or factors that cause individuals to join gangs; whereas, other studies focus on particular study groups based on age, gender, or ethnicity.

This chapter examines street gangs and the different profiling methods used today. Specifically, this chapter examines the different indicators more in depth as to why individuals join street gangs. Knowledge of these different indicators will be important in order to develop the proposed models in Chapter 3. Following the discussion of indicators and profiling, a section is provided linking terrorist groups to ordinary American street gangs in terms of likely recruits. The final sections of this chapter discusses possible models to be used in studying gangs and provides a more in depth background on Ishikawa Diagrams and the VFT process.

Street Gangs

Defining the term gang is difficult. Merriam-Webster (2007) defines a gang as a "group of persons having informal and usually close social relations." Hagedorn (2005) explains the definition stating "gangs today are organization of the socially excluded, most of whom come and go as their wild, teenage peer group ages" (156). Other definitions of gangs have consisted of "a gathering of individuals with a specific negative set of personal attributes or a group of individuals who act in a deviant and/or criminal

manner" (Sanchez-Jankowski, 2003:191). A number of definitions exist, but all primarily focus on a group of similar attributes, typically teenagers, whom participate in criminal activity. The definition of street gangs used in this thesis is "individual members, gang cliques, or entire gang organizations that traffic drugs; commit shootings, assaults, robbery, extortion, and other felonies; and terrorize neighborhoods" (Johnson, Webster, & Connors, 1995:2).

Types of gangs vary widely throughout the United States as well as the world. Gangs can form based on location, religious views, blood "type", race, presence in an institution, and many other factors. This thesis focuses on the formation of street gangs. The definition of street gangs also vary widely, but one definition has been chosen. A street gang is "any durable, street-oriented youth group whose own identity includes involvement in illegal activity" (Klein, 2005:136). Street gangs were chosen in this research because it is found to be a gang type that may not require the member to be of a specific race, religion, or social status. However, it is important to note that street gang members can be members of other gangs such as a prison gang, which will be shown in section 2.1.2.

Street gangs have many comparisons and contrasts to organized crime organizations. Both types of organizations pose a serious threat and problem to the government and nation. However, the two groups should be distinguished from one another. Papachristos (2005) claims that "treating all gang members like mafia kingpins or terrorist masterminds is overestimating people who, more often than not, are petty delinquents" (55). Hughes and Short (2006) feel it is unproductive to focus on the gangs that act like organized crime groups even though these groups are also a problem to

society. This thesis focuses on the street gangs that are not involved with organized crime; however, it is important to note that some of the originations of street gang activity stem from organized crime, such as the Mafia, as explained in section 2.1.2.

The presence of gangs has been prevalent throughout the world for many years. It is important to understand that "gangs can no longer start and stop with local conditions but must also be rooted in a global context" (Hagedorn, 2005:153). Immigration has influenced the growth of gangs, particularly in the United States. "The immigrant experience has produced gangs that have been primarily, although not exclusively, predatory on their community" (Sanchez-Jankowski, 2003:204). This study focuses primarily on American gangs and research done on these specific gangs, but it is important to be aware that the information can pertain to gangs throughout the world.

Many descriptive, family, and economic/social factors play a role in an individual's desire or reasoning to join a street gang. Each member may have different reasons for joining, but overall as a group, share similar traits. The following sections further examine the different possible factors for an individual participating in a street gang, and serves as a basis for information necessary to develop a psychological profile of a street gang member.

Descriptive Traits

Ages of gang members can vary more widely than the common perception. Definitions of street gangs all contain the word youth or teenager implying members in their teens. Much of the research done on street gangs involved surveying teenagers, such as the survey performed by Craig *et al*. (2002) when they asked males from ages 10-14 whether or not they have participated in gang activity. A study performed by Lasley

(1992) found that “most street gang members are likely to be adolescents who give up their street gang affiliations upon reaching adulthood” (448). However, as previously stated, Sanchez-Jankowski (1991) found that even though most members are in their teens, the ages can extend to 30 or more. The older members could be the founders of the gang or the more prominent members who help guide the younger, newer participants. It is important to determine the age of gang members because “13-year-old gang boys can be diverted more easily from illegal street activity than adult criminals in their early 20s can be” (Fleisher, 1995:152).

The gang membership is not limited to males, but can include females as well. Klein (2005) suggests that “the police greatly underestimate levels of female gang membership” (140). Studies performed independently by Fagan (1990), Klein (1971), Maxson & Whitlock (2002), Miller (2001), and Moore (1991) have found that females in gangs are usually younger than the males and exit the gangs much sooner than the males. They have found that gangs are anywhere from 10-38 percent female. These authors also refute previous claims made that females primarily serve as sex objects within the gang, but rather found that the female gang members participate in the same illegal types of behavior as males, although often on a smaller level.

Although some gangs exist in which a particular ethnic background is required to be a member, such as the KKK or Latin Kings, traditional street gangs do not follow the same rule. “Street gangs are territorially based and may include Mexican, Puerto Rican, black, and even white members, depending on the ethnic composition of the local neighborhood” (Cummings, 1993:170). Klein (2006) suggests that street gangs in America can comprise of many different ethnicities, but typically falls under the

classification that most gangs are made up of Hispanics and African Americans, rather than Asians or Caucasians. No present research indicates that a particular ethnicity determines that one will join a gang; gangs appear in every racial and ethnic group (Larson, Kittleson, & McCay, 2005). They do, however, show trends in particular areas of the world.

Economic/Social Factors

Income levels of teenagers and their families can have a major effect on the teen's desire/need to join a gang. "Gangs have consistently emerged from low-income communities where there has been a scarcity in resources" (Sanchez-Jankowski, 2003:208). Some teenagers fear they may fall into the same fate as their parents and be forced into working a dead end job and living a lifestyle viewed as negative. To avoid this, gangs have "emerged as organizations that provide a social haven for young people to experience fun and pleasure before assuming jobs and a concomitant lifestyle" (Sanchez-Jankowski, 2003:205). Along with this lifestyle, gangs promise the new members incomes that would not seem attainable if they followed the law abiding life of their parents (Portes & Rumbaut, 2001).

Gang members and their respective gangs usually accumulate money in an illegal manner. One possible way to gain funds is by extorting monies from local business owners in the neighborhoods (Vigil & Yun, 1990). Another way, more popular among the younger and newer gang members, is by stealing. Stealing is a method used by the senior gang members to allow the new members to "prove themselves" but still make a profit in the process (Cummings, 1993:188). Cars, weapons, and other commodities become the main targets for these gang members. However, this method of income can

be relatively insignificant and while more thrilling, may not prove to be better than "turning hamburgers at McDonald's" with the amount of risk involved for such small payouts (Cummings, 1993:191).

Another area attributed to the success of gangs is drugs. It was once thought that the Italian Mafia was the sole controller of the drug trade among American communities (Sanchez-Jankowski, 2003). However, with more immigrants from drug yielding countries coming to the United States, street gangs have gradually taken over the drug industry. As a result this take over has attracted new gang members in two different ways. One option available is new gang members feel they have an "endless" supply of drugs they can access at their disposal (Sanchez-Jankowski). Another attraction to new gang members is the promise of a substantial amount of money to be made from producing and selling the drugs to contacts already established by the current gang members (Fagan, 1989). In 2001, was estimated that "approximately 42 percent of gangs were involved in the street sale of drugs for the purpose of financial gain" (Trojanowicz, Merry, & Schram, 2001:198); however, this number could be higher as of 2008.

Peer pressure is often a topic of discussion concerning the behavior of children and teenagers. A study performed by Craig *et al*. (2002) on adolescent males shows that those who have friends that are members of a gang typically join a gang themselves. Cairns and Cairns (1991) support this observation with their finding that aggressive children will form friends with other aggressive children.

Along with peer pressure is the teenager's or young adult's need to feel accepted. "Youths who experience alienation and a sense of powerlessness from their environment find acceptance in the gang" (Delaney, 2006:111). Galinsky and Salmond (2002)

conducted a national survey and found that youth needed acceptance and turned toward gangs to satisfy this need. Zimmerman, Morrel-Samuels, Wong, Tarver, Rabiah, & White (2004) analyzed a group of young adolescents' essays written about gangs and found that acceptance is indeed an antecedent to joining and participating in gangs. These authors also found that females were more likely to report the need to feel accepted as a reason for joining a gang than the males. Knox (2001) found that nearly half of female gang members join a gang because their boyfriend is currently a gang member. In short, joining a gang allows the individual to feel part of a "family" or a close group of friends.

Another factor that supports an individual's need or desire to join a gang is survival. In some areas, such as the streets in depressed or crime ridden areas, sometimes the only way to survive is to have protection. Delaney (2006) explains that even though some individuals try to remain neutral by not joining any local gangs, some of the gangs may perceive them to be a member of a rival gang and, therefore, they are the enemy. By joining a gang, "youths believe they are safe from attacks by other gang members or conventional youths who are bullying them" (Delaney, 2006:112). Johnstone (1983) supports this notion in explaining that youth join gangs for self-protection after they have been victimized in some way by either other gangs or bullies.

One other societal reason for joining a gang is incarceration. According to Sanchez-Jankowski (2003), it was thought that prison gangs and street gangs were considered to be separate and not affiliated with one another. However, with the increase of street gangs involved with drugs, the number incarcerated has also increased. This has caused a unification of street and prison gangs (Sanchez-Jankowski, 2003). Inmates are

joining prison/street gangs on the inside, and upon release, continuing their membership with the associated street gang on the outside. Recidivism is also at a high rate, making the reason to join an affiliated prison gang while on the inside and having a street gang available when not incarcerated even more important (Hughes, 2006). This assimilation of prison and street gangs are attractive to current or potential inmates because of an individual's need to be accepted or to be protected from and by other dangerous inmates, as discussed previously by Delaney (2006).

Family Life

Broken homes can provide many hardships for teenagers to face and handle. The effects of a broken home can be "economic hardships, the loss of some affection, the loss of proper role models necessary for socialization, and fewer barriers to the development of friendships with delinquents" (Trojanowicz *et al*., 2001:141). Delaney (2006) supports this notion in stating that "youths who come from broken homes are more likely to become delinquents, whereas children who are raised in healthy, intact homes are less likely to become delinquent" (110). No current research has found a direct correlation between delinquency and the absence of the nuclear family, but much research holds that it is an indicator.

Dysfunctional families can also create an environment in which drives individuals to join a street gang. Merriam-Webster (2007) defines dysfunction as "abnormal or unhealthy interpersonal behavior or interaction with a group." It can be difficult to pinpoint specific characteristics or instances that lead to a family being considered dysfunctional. Much research done on street gangs and dysfunctional families suggest potential causes for an individual to join a gang are abuse (physical, verbal, or sexual),

drugs and alcohol in the home, and legal problems for the family. These problems can hinder strong ties to the family and are a likely cause contributing to family member being attracted to the gang life (Hirschi, 1969).

Abuse, no matter what type, is very damaging to individuals and can cause delinquency. Yoder, Whitbeck, & Hoyt (2003) states that "it is expected that parents who engage in delinquent behavior and who abuse their children will, in turn, have children who engage in delinquent behaviors, which increases their likelihood of gang involvement" (448). Typically, females seek out gang membership to protect themselves from the physical and sexual abuse experienced from their fathers or other male family members (Delaney, 2006).

> "A gang serves as a refuge for young women who have been victimized at home. High proportions of female gang members have experienced sexual abuse at home" (Moore & Hagedorn, 2001:3).

Drug abuse by parents can affect their children in several different ways. One is that drug use can disrupt the parents' ability to parent the child which leads to antisocial behavior in the child's life (Dishion, Nelson, & Yasui, 2005). Another avenue to effect the child is parental drug use. This "consumption of alcohol and drugs may encourage or facilitate criminal behavior, especially violence and aggression" (Curran & Renzetti, 1994:122). As discussed previously, drugs can also be a possible source of illegal income for the individual if they choose to sell within the gang. On the other hand, potential drug addiction often contributes to lower economic household standing.

Legal problems within the family can also lead to individuals joining street gangs. Financial problems or low income can also be a determining factor (Sanchez-Jankowski, 2003). In addition, divorce can create problems for teenagers by leading to broken homes

and the problems associated with these conditions (Delaney, 2006 & Trojanowicz *et al*., 2001). Incarceration of one or both parents also leads to broken homes and can attribute to delinquent behavior of the "homeless" child (Yoder *et al*., 2003).

In short, "rejected or neglected children who do not find love and affection, as well as support and supervision, at home, often resort to groups outside the family; frequently these groups are of a deviant nature" (Trojanowicz *et al*., 2001:143). Maslow's (1951) hierarchy of needs comes into play when dealing with society and family factors of why individuals join gangs. The first three stages are basic survival needs, safety and security needs, and love and belongingness needs. Maslow (1951) asserts that if these three stages are satisfied by the family, the child should move onto the next two stages without disruption. However, not attaining these needs from the family can turn the adolescent toward street gangs for these needs to be satisfied (Delaney, 2006).

Profiling

Profiling is a technique that can be used to identify possible suspects or targets in a real world situation. Merriam-Webster (2007) defines profiling as the "act of suspecting or targeting a person on the basis of observed characteristics." Profiling is used throughout the world, in detective work, national security, and even the business world. "Man has always been interested in understanding his adversaries, competitors, and even his friends" (Turco, 1990:147). Different types of profiling exist; some have different names but are very related to one another. The following sub section discusses these different profiling techniques and advantages or disadvantages of profiling in general.

Psychological Profiling

Psychological profiling is differentiated as a number of different types of profiling such as criminal, offender, or even criminal personality profiling (Egger, 1999). For simplicity in this thesis, these four types of profiling will all be categorized as psychological profiling. Mokros & Alison (2000) define psychological profiling as "the process of predicting the characteristics of an offender based on information available at the crime scene" (25). Another definition describes a psychological profile as "an educated attempt to provide investigative agencies with specific information as to the type of individual who committed a certain crime" (Geberth, 1981:46). A third similar definition is that a psychological profile "focuses attention on individuals with personality traits that parallel traits of others who have committed similar offences" (Pinizzotto & Finkel, 1990:216).

Psychological profiling derives its uses from the ideas of "after the fact" profiling. This involves attempting to solve a crime that has already occurred and using evidence or clues from the actual crime scene to "predict the characteristics of an offender" (Mokros & Alison, 2002:25). The avid users of this type of profiling crime scene detectives, forensic scientists, police, and even psychologists or psychiatrists (Bumgarner, 2002).

Official recorded use of the psychological profiling has only been in existent since World War II. Dr. W.C. Langer was approached by the OSS (the precursor of the CIA) and was asked to submit a profile of Adolph Hitler (Turco, 1990; Egger, 1999). Langer prepared a personality profile of Hitler to give the OSS insight on what decisions Hitler would make given different situations. This profile was deemed a success and considered very accurate because "it included Hitler's suicide when Berlin was taken by the Allies"

(Egger, 1999:244). The development and final copy of this profile was originally classified as top secret, but was later published in 1972 (Turco, 1990). Such efforts to profile foreign leaders of interest are believed to continue to date.

Psychiatrist James Brussels is another popular profiler who helped the NYPD by developing a psychological profile of the Mad Bomber (Egger, 1999; Douglas, 1995). Brussels examined the many letters and different crime scenes to determine what kind of person was responsible for these bombings (Egger, 1999). The final profile suggested looking for a foreign, middle-aged man, who was single, Catholic, lived with a brother or sister, and wore a buttoned up double breasted suit (Douglas, 1995:34). NYPD found the bomber and Brussels's profile was completely accurate other than the bomber lived with two maiden sisters (Egger, 1999).

In 1964 Brussels was commissioned once again to use his psychological profiling technique to help capture the Boston Strangler (Kocsis, 2004; Egger, 1999). Brussels used the same type of technique in taking evidence from the crime scenes and letters provided to find the Boston Strangler. Eventually police captured a man by the name of Albert DeSalvo who was convicted as the Boston Strangler; Brussels's profile fit DeSalvo very accurately (Kocsis, 2004). Brussels has shown that "interpreting the bizarre behavior of these killers and then translating this psychiatric knowledge into investigative realities had proven to be a very effective tactic" (Egger, 1999:244).

However, psychological profiling has not always been an aid or correct in identifying the perpetrator. At the bombing of the 1996 Olympic Games, officials profiled the bomber to be a security guard present at the bombsite (Kocsis, 2004). Months later the officials determined the profile was wrong, costing them time, money,

and embarrassment, as well as creating a strong suspicion of the innocent guard who had discovered the bomb.

Several case studies have been conducted to determine the proficiency of psychological profiling compared to other methods already established used to catch criminals. Pinizzotto (1984) conducted an analysis of 192 known uses of psychological/offender profiling used by the FBI. Pinizzotto found that 77% gave a clearer focus; with 46% benefiting the investigation, but only a reported 17% was found to be very helpful in the identification of the criminal. Several years later, Pinizzotto and Finkel (1990) performed a study using six professional profilers and compared them to detectives, psychologists, and university students. Their findings showed that the profilers' profiles were either just as effective or sometimes superior to solve the crime compared to the other groups. Kocsis (2003) performed a similar study, using 11 professional profilers and more comparative groups than Pinizzotto and Finkel (1990). Kocsis (2003) found that "some affirmative indication emerged to the effect that the sampled profilers were capable of outperforming the other tested groups" (134). Kocsis recognizes that the empirical study was very small, but to date, this is the only public information available on how effect psychological/offender profiling truly has been.

Geographic Profiling

Geographic profiling can be used in conjunction with psychological profiling to aid in identifying the location of the suspect. Geographic profiling assists in describing the location of the subject based on the known crime scenes committed by the suspect (Rossmo, 2000). This type of profiling is mathematically intensive and gives a precise level of significance (Snook, Zito, Bennell, & Taylor, 2005; O'Leary, 2005). Some

strengths to geographic profiling include that the framework is extensible, mathematically rigorous, and the underlying assumptions of criminal behavior are open for change. However, some weaknesses are the lack of a simple closed model, the assumption that crime scenes are independent and identically distributed, and the framework only being as good as the model itself (O'Leary, 2005). Due to these weaknesses, erroneous information can lead to bad estimations on the locations of the suspect or other misinformation.

Racial Profiling

Racial profiling is "any use of race, religion, ethnicity, or national origin by law enforcement agents as a means of deciding who should be investigated, except where these characteristics are part of a specific suspect description" (Angulo and Weich, 2002:11). Lippert-Rasmussen (2006) agree with this definition and add that racial profiling is

> "morally problematic for various incidental reasons; for its association with racial hostility, double standards, prejudice influencing the formation of statistical beliefs about crime rates in racial groups, biased conceptions of what constitutes crime, and so on" (191).

Simply put, authors tend to focus on the fact that racial profiling has issues of discrimination and inaccuracy (Innes, 2003).

Racial profiling is an example of group profiling or group identity profiling (Lippert-Rasmussen, 2006). It is more likely that "police officers stop, search and questions people of a certain race because members of this group are believed to be more likely to possess illegal drugs" (Lippert-Rasmussen, 2006:191). Mamdani (2004) explains that American have tendencies to group all individuals that fit a particular

characteristic. It is important to note that racial profiling is only the use of one factor, such as race or religion, to suspect a person to be guilty of a crime. However, profiling may not be racial profiling if it includes race, religion, or national origin as one factor among many others rather than being the sole or primary factor (Gallo, 2003).

Effectiveness of Profiling

Whether profiling should be implemented is a popular topic of debate. As stated previously, Pinizzotto's (1984) study found that some types of profiling at least provided a clearer focus 77% of the time. Pinizzotto and Finkel (1990) and Kocsis (2003) each found that given a controlled study, the profilers performed just as well or better than detectives and other officials that do not use profiling. The profiles developed by Brussels were also accurate in describing the criminals responsible for the bombings and strangling. "Statistically, profiling does work. In addition to the statistical argument, supporters of profiling point out that it is common sense" (Bumgarner, 2002:68).

Profiling and the War on Terror

Since the attack on the World Trade Center, America has been engaged in the War on Terror. It was President Bush's plan to rid the world of this evil, but some feel that "even as the war is presented to the world as a defense of democratic rights and freedoms, the U.S. administration is institutionalizing racial profiling as a domestic security measure" (Thobani, 2004:597). Where to send American military troops was based not only on the location of Bin Laden and Hussein, but also on the use of profiling. "It was obvious after September 11 that al-Qaeda's sanctuary in Taliban-run Afghanistan had to be occupied by U.S. forces and the al-Qaeda leaders killed" (Clark, 2004:245). Based on the notion that locations with Taliban associated individuals were necessary to

occupy, primary countries to invade were Afghanistan, Iran, Saudi Arabia, and Pakistan (Clarke, 2004).

Terrorist Groups

Terrorism comes from the Latin word of terrere, "which means to frighten" (Miller, 2006:121). Merriam-Webster (2007) defines terrorism as the "systematic use of terror especially as a means of coercion." The FBI (2004) defines terrorisms as "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." The DoD (2007) attributes terrorism to the "calculated use of unlawful violence to inculcate fear; intended to coerce or intimidate government or societies in pursuit of goals that are generally political, religious, or ideological."

Reasons for Terrorism

Terrorism has been practiced since the dawn of time (Merari & Friedland, 1985) but one of the first use of the word terrorism came from the French Revolution's "Reign of Terror" (Miller, 2006). The definitions given previously outline the popular reasons for terrorism: Political, religious, or ideological. Many other reasons, either personal or public, can exist for terrorism. One of these reasons for why terrorists may attack could be feelings of humiliation (Stern, 2003). While the list is potentially endless, the few that will be focused on here will be more political and religious.

"Terrorists use violence to achieve political change" (Horgan, 2005:8). Some groups, such as Marxists groups, use terrorism to overthrow governments to replace them with ones lead by themselves or a government the terrorists themselves would like to see in place (Kydd & Walter, 2006). Other groups, such as many of the terrorist groups in

Islamic regions, wish to establish Islamic states in other countries as well as reduce the amount of influence and support the United States' government and other Western nations has in these countries (Kydd & Walter 2006). This is seen as a territorial change but also involves the use of politics and religion as a reason for terrorism. Table 2 gives the known goals for a sampling of different terrorists groups according to the U.S. Department of State as of 2005. As seen in the table, political reasons attribute to many of the terrorists groups for violence in particular areas.

Table 2. Terrorist groups and their ultimate goals (U.S. Department of State, 2005)

Terrorist Group	Ultimate Goal
Popular front for the Liberation of Palestine	Destroy Israel; establish Palestinian state
Al-Qaida	Destroy Israel; Establish Islamic states in Middle East; Reduce U.S. influence
Al-Qaida in Iraq (Zarqawi)	Evict U.S. in Iraq; Establish Islamic State
Real Irish Republican Army	Evict Britain from N. Ireland; Unite with Elre
Revolutionary Armed Forces of Colombia	Establish Marxist state in Colombia
Revolutionary Nuclei	Establish Marxist state in Greece
Revolutionary Organization	Establish Marxist state in Greece
Revolutionary People's Liberation Party/Front	Establish Marxist state in Turkey
Salafist Group for Call and Combat	Establish Islamic state in Algeria
Shining Path	Establish Marxist state in Peru
United Self-Defense Forces of Colombia	Preserve Columbian state

Religion can have a large effect on terrorists' acts as well. "Terrorism motivated by religion is becoming more common and more lethal" (Falkenrath, Neman, & Thayer, 1998:181). Terrorism in the name of religion often leads to the concept that the terrorists are "successfully fulfilling the will of god by fighting a 'corrupt' Western culture" (Pech & Slade, 2006:18). Gigantes (2003) describes different verses in the Koran which Muslims follow (220):

- Allah knows everything (i, 15).
- A Moslem can do nothing about his death as the time is appointed by Allah and if he dies in a jihad – a holy war – he will go to heaven regardless of what he has done (iv, 74).
- In heaven any believer who dies in jihad will be forever young and potent; he will be given 70 virgins who will also be forever young and libidinous. There will always be wonderful fruit, rivers of milk and honey and wine (xlvii, 15; lxxvi, 14-15; lv, 56-58).

These reasons are often cited as popular justifications for Muslims or similar religious groups have for uses of terrorism.

Determining exactly who joins a terrorist group and why the particular individual joins a terrorist group is still an intensely debated area. Some authors, such as Victoroff (2005) had attempted to take unstructured interviews and published papers to match psychological characteristics of terrorists. Weatherson and Moran (2003) attempted to argue that mental illness attributes directly to becoming a terrorist. Many different reasons can occur as well as a "culmination of a succession of life events and periods of reflection" can cause someone to "wake up one day and decide to be a terrorist" (Miller, 2006:126).

Terrorist Groups and Street Gangs

The purpose of examining terrorist groups in this thesis is to see a terrorist group, and their possible recruits, as similar to the recruits of an ordinary street gang. Terrorist groups may commit more heinous crimes on a larger scale than street gangs and have an established doctrine, but have similar goals and outlooks on society. However, this thesis

does not assert a direct relationship between street gangs and terrorist groups, but rather attempts to uncover similarities between who is likely to join the two groups and some of the causes or indicators behind possible recruits.

Statistical Analysis

The use of linear regression and multivariate analysis along with other statistical techniques can provide great insight into how groups work. However, the necessity of large amounts of validated data is crucial. In addition, knowledge of the data and statistical methods is very important to understand what they data are portraying to the analyst. With proper data, multivariate analysis can be a proverbial aid to identifying "at risk" children by different factors. This data, however, is often protected due to the personal nature and juvenile status of the offenders. The lack of data, such as open source data, in this thesis requires an approach to examine different models to help explain behavior, physical attributes, and other characteristics that might describe what individual would join a street gang. Should valid data be available, however, appropriate multivariate techniques should be considered.

Models

Models and frameworks can be useful in the absence of large amounts of data or in conjunction with collected data (Hesse & Woolsey, 1980). Several models were examined that exhibit promise to be used in the area of determining who joins a street gang. The uses of these models are fairly selective just to the area of street gangs, but similarities will be shown in the area of terrorist recruiting. However, it is important to understand these models can be built on for expansion and also revised to remain consistent with the times and situations.

Ishikawa (Fishbone) Diagram

The Ishikawa diagram, also known as a fishbone diagram, cause-and-effect diagram or a characteristic diagram was developed in 1943 by Professor Kaoru Ishikawa (Ryan, 2000; Herrmann, 2001). Ishikawa diagrams stem from the area of quality control but have been used in many other areas such as business, healthcare, psychology, profiling and other areas (Phipps, 1999; Barry, Murcko, & Brubaker, 2002; Kleen, 2001). "Virtually any problem can be tackled using this powerful tool" (Brussee, 2004:36). The Ishikawa diagram is a "method for systematically reviewing all factors that might affect a given objective or problem" (Herrmann, 2001:72).

An Ishikawa diagram is first constructed by determining what problem needs to be solved. This problem is the main "bone" of the diagram and all causes of this problem stem off as branches or bones (Herrmann, 2001:72). All the main possible underlying causes are first drawn off the main bone. To help feed a starting point for these causes, Herrmann (2001) and Streibel (2003) present different starting points for the underlying causes: The 4 M's (methods, materials, machines, and manpower), the 4 P's (places, procedures, people, and policies), and the 4 S's (surroundings, suppliers, systems, and skills). Some authors suggest three to six main underlying causes (Herrmann, 2001); however, no set number exists for the purpose of the Ishikawa diagram is that it needs to be complete of all possible causes.

From these main underlying causes, secondary factors or causes are represented by drawing a branch or bone off each main cause. This continues until the sub areas can no longer be reasonably divided or expressed (Herrmann, 2001). Usually, the maximum depth levels will go to about four or five to encompass all possible main and sub causes

(Hermann, 2001; Streibel, 2003). Once the causes are entered into the diagram, the Ishikawa diagram is complete.

Different interpretations of the steps necessary to develop an Ishikawa diagram exist; however, they all follow a similar pattern. Pyzdek (1991:113) provides a simple five step procedure in developing Ishikawa diagrams:

1. Develop a flowchart of the area to be improved.
2. Define the problem to be solved
3. Brainstorm to find all possible causes of the problem
4. Organize the brainstorming results in rational categories
5. Construct a cause-and-effect diagram that accurately displays the relationships of all the data in each category.

For step 5, a more detailed three step description is given as well:

5.1. Draw a box on the far right-hand side and draw a horizontal arrow that points to the box. Inside the box, write the description of the problem to be solved
5.2. Write the names of the categories above and below the horizontal line. Think of these as branches from the main trunk of the tree.
5.3. Draw in the detailed cause data for each category. Think of these as limbs and twigs on the branches.

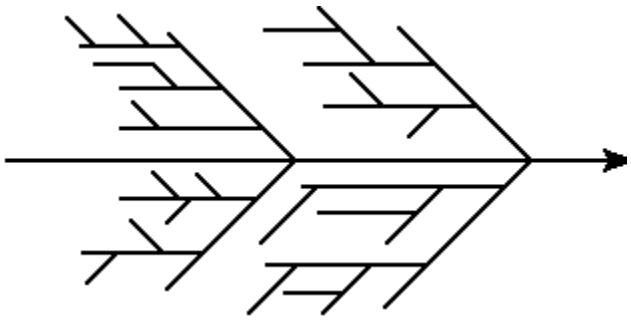


Figure 1. Example Ishikawa "Fishbone" Diagram (Skymark, 2008)

Ishikawa diagrams provide a number of beneficial insights to a problem analysis. It is a tool that encourages a great deal of brainstorming to be done on one particular problem, allowing every person involved in the process to voice their opinion on what cause might exist in the system (Herrmann, 2001; Streibel, 2003). The bones (or branches) can be added onto later and clearer conclusions can be drawn in the future (Ryan, 2000). Along with brainstorming, the development of the Ishikawa diagram can lead to a clearer focus and even a possible solution to the problem (Brussee, 2004). The Ishikawa diagram allows all the relevant information to be gathered and organized in a particular fashion that is easy to understand and implement (Barry *et al*., 2002). The Ishikawa diagrams, as stated previously, can be used in a variety of settings. This will be shown in this thesis by developing a profile of a possible gang recruit.

Although there are a number of advantages, some setbacks and criticisms exist with the use of Ishikawa diagrams. One weakness of the diagram is that it does "not distinguish very well among mechanisms, conditions, and constraints" (Barry *et al*., 2002:60). Other weaknesses have been stated that Ishikawa diagrams are too subjective and cannot perform the amount of analysis that Design of Experiments (DOE) can offer (Burt & Pinkerton, 1996). However, there are several statistical (and graphical) techniques that assist Ishikawa diagrams that were also developed in the area of quality control (Ryan, 2000; Hubbard, 1999). These techniques consist of histograms, Pareto charts, scatter plots, and control charts. It is important to note that Ishikawa diagrams are useful if faced with a lack of data. However, if appropriate data exists, one can use the available data in conjunction with the Ishikawa diagram to gain a deeper understanding of what might be causing different factors or what effect these factors have on the entire

problem. In addition, Ishikawa diagrams can serve as a guide in determining data requirements of the problem and how that data might be used for future research (Herrmann, 2001).

Value Focused Thinking

"Value focused thinking is a way to channel a critical resource - hard thinking - to lead to better decisions" (Keeney, 1996:537-538). Some decisions can be simple to make, but the more complex a decision context becomes, the more difficult the decisions may be to make. Value focused thinking allows the decision maker (DM) to focus on the *values* of the decision rather than the different alternatives presented to the DM. Value focused thinking also provides a framework or knowledge base to develop or design new alternatives (Kirkwood, 1997).

Alternative focused thinking is the method in which a DM makes the decision simply by choosing an alternative without potentially directly considering the values involved in the decision. "Focusing on alternatives is a limited way to think through decision situations" (Keeney, 1996:537). The values involved in decisions are what should be important. These values may be of several different forms: "Purposes, desires, ends, 'what is important,' 'what is of concern,' 'what satisfies' – in short, what the person wants to achieve through the decision" (Leon, 1999:214). Advantages are gained when thinking about the different values that go into a decision that could be missed when performing only alternative focused thinking (Keeney, 1992).

Value focused thinking (VFT) uses the idea of value hierarchies to assess a specific decision at hand. A value hierarchy is a structure that encompasses all the values

a DM deems important in the decision at hand, typically taking a "treelike" form (Kirkwood, 1997:12). Figure 2 gives an example of a generic value hierarchy.

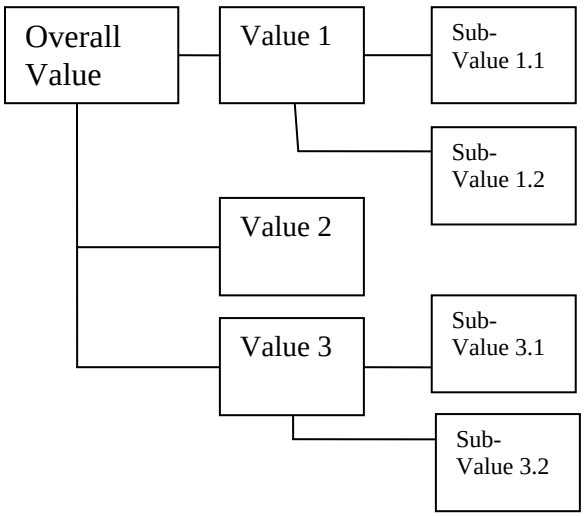


Figure 2. Example Value Hierarchy with only values.

To construct the value hierarchy, different values pertaining to the decision must be solicited from the DM. Brainstorming or other techniques are used to gather all the values and ideas from the DM. This list of values and ideas is then used to create affinity diagrams or other approaches to organizing thoughts such as the Ishikawa diagram. Affinity diagrams take large amounts of information and divide them into different groups of commonality (Kirkwood, 1997). Each group has a common term that associates all of the members within the group. These terms then become the top level or first tier of the value hierarchy. Sub-tiers are then created from the first tier until the fundamental objective (ultimate objective) is achieved by the DM (Kirkwood, 1997). It is important to note that all objectives on the lowest tier must be measurable with a single valued evaluation measure associated with the objective.

Following the construction of the value hierarchy, each value on the lowest tier must have a single dimensional evaluation measure(s) that best measures the associated value. Kirkwood (1997) discusses four different evaluation measures: Natural or constructed and direct or proxy (24). Natural measures are those that are common to all people. Profit in dollars is commonly used in different business situations as a natural measure (Kirkwood, 1997:24). Constructed measures use a particular scale that is constructed by a subject matter expert (SME). These measures are used if no natural measure (Kirkwood, 1997:24). An example of a constructed scale is the gymnastics scoring system.

"Direct scales directly measures the degree of attainment of an objective" (Kirkwood, 1997:24). A direct measure can be the miles per gallon that a car attains. Proxy measures are present only if no direct measure exists. These measures indirectly measure the degree of attainment of an objective (24). A common proxy measure used is student grades. The different combinations of measures are given, with preference in the order given: Natural/Direct, Natural/Proxy, Constructed/Direct, and Constructed/Proxy. Table 3 summarizes different examples for these classifications.

Table 3. Measure Classification Examples (Kirkwood, 1997:24)

	Natural	Constructed
Direct	Profit in dollars Miles per gallon	Gymnastics Scoring System
Proxy	Gross National Product	Student Grades

One other important property of an evaluation measure is that it must be monotonic. This simply means that the scale on which the evaluation measure is evaluated must be either non-increasing or non-decreasing. If the evaluation measure is not monotonic, a new evaluation measure must be developed. The final step in

developing evaluation measures is determining the preferred ranges on which the evaluation measures exist. The DM is asked to give their most preferred (x_i^*) and least preferred (x_i^o) values which are evaluated. These may represent the lower and upper bound of the actual scale, or two values within the two bounds.

Single dimensional value functions (SDVFs) allow the analyst and DM to assign values between 0 and 1 on any given input from the evaluation measures. Typically a 0 is assigned to the least preferred value, 1 is assigned to the most preferred value, and the rest of the values fall somewhere in between. Two different procedures exist in creating value functions; one results in a piecewise linear function and the other an exponential function. "While the use of one may result in a somewhat different specific shape, the difference is not of practical significance" (Kirkwood, 1997:61).

The main idea in using piecewise linear functions is the use of value increments. Break points are created at significant bounds determined by the DM and SMEs. These value increments are then measured against each other and a function is derived from the value increments. Kirkwood (1997) gives a simple four step process in determining a piecewise linear single dimensional value function (64):

> 1. Place the value increments in order of successively increasing value increments for "more is better". Do the opposite for "less is better."
> 2. Quantitatively scale the value increments as multiples of the smallest increment.
> 3. Set the smallest value increment so that the total of all the increments is 1.
> 4. Use the result of step 3 to determine the single dimensional value for each possible score of the evaluation measure.

Once these four steps are accomplished, the values are graphed to display where the scores lie for each input. The piecewise linear graphs can also be represented with categorical data. This data exists when there is no continuous line that can be drawn. These graphs can be seen in Appendix A for the gang model example.

If no break points are necessary in the function, then the use of exponential SDVFs may be suggested. Exponential SDVFs are simpler than piecewise for only three points are necessary to complete the function: The two endpoints and some chosen midpoint. These exponential SDVFs can also be linear (midpoint is in the middle of the range) or an S-curve. Derivation and proof of the exponential SDVFs are shown in Kirkwood (1997:65-70). After finding rho (as explain in Kirkwood), one of two equations are used to determine the value or score of each evaluation measure (65):

For "more is better"

$$v(x) = \frac{1 - \exp[-(x - x_i^o)/\rho]}{1 - \exp[-(x_i^* - x_i^o)/\rho]}, \rho \neq \infty \quad (1)$$

$$v(x) = \frac{x - x_i^o}{x_i^* - x_i^o}, otherwise \quad (2)$$

For "less is better"

$$v(x) = \frac{1 - \exp[-(x_i^* - x)/\rho]}{1 - \exp[-(x_i^* - x_i^o)/\rho]}, \rho \neq \infty \quad (3)$$

$$v(x) = \frac{x_i^* - x}{x_i^* - x_i^o}, otherwise \quad (4)$$

Weighting the hierarchy allows the user to determine how much effect each value has on the overall decision. To determine the local weights for the different values, the

use of “swing” weighting is recommended. While performing swing weighting, the DM is asked to compare two values against one another. The DM is then asked to swing each value from its least preferred to most preferred, and determine which is more important. After determining which is more important, the DM is asked to associate a number indicating how much more important it is, similar to value increments in the evaluation measures. Values are compared within the same tier and each tier’s weights sum to 1.

These value hierarchies provide the DM with several benefits. The first benefit is that the hierarchy acts as a guide to collect information about the decision (Kirkwood, 1997). The hierarchy assists in clarifying what additional information is important to obtain in order to continue on in the decision. Another benefit, previously stated, is that VFT can help to identify either existing or new alternatives (Kirkwood, 1997).

A third benefit of VFT is that it helps facilitate communication among the decision makers involved (Kirkwood, 1997). Different DMs (or stakeholders) may want to voice what they feel is important in the decision; the final value hierarchy captures each person’s values and can provide a “better basis for compromise and/or consensus with regard to selecting alternatives” (Kirkwood, 1997:23). The final benefit of VFT is an established, traceable, and formal method in which each alternative is scored and evaluated (Kirkwood, 1997). VFT ranks the different alternatives and also exhibits the different values that impacted each alternative respectively. This serves as a mean to see which types of alternatives fair better than others and which are not promising in satisfying the values.

To attain the benefits the value hierarchies provide, there are desirable properties in the construction of value hierarchies. The first property is that the value hierarchy

must be complete (Kirkwood, 1997:16). Each value is divided to lower tiers till it can be represented as an associated single dimensional value function (SDVF). Another property is that the value hierarchy should not have any values or evaluation measures that overlap in the same tier to avoid double counting a value (Kirkwood, 1997:16-17). These two properties allow the value hierarchy to be "collectively exhaustive and mutually exclusive" (Kirkwood, 1997:17).

Preferential independence, one value's SDVF not being dependent on the level of another value, is required in a value hierarchy. This property allows the values to be independent of one another. A value hierarchy must also be easily understood by those who use the hierarchy (Kirkwood, 1997:18). If the DM cannot understand what information the hierarchy is conveying, the DM will not be able to explain its use and operability and more critically, he or she may not choose to use a hierarchy they do not understand. The final property important in a value hierarchy is that a small hierarchy is desired (Kirkwood, 1997). The smaller the hierarchy is, while still meeting the other requirements, the more easily it is explained and fewer resources that are required to obtain an answer.

The use of VFT in this thesis requires knowledge of adolescents who might be considered "at risk" in society. Different possible decision makers could be psychologists, psychiatrists, behavior counselors, police officers, or more specifically geared towards gangs, an expert in the field of gangs. Information can be gathered from one or more of these experts to develop a value hierarchy that resembles a profile of one who might join a street gang.

VFT is beneficial in that it uses a value model to score different alternatives. In this study, VFT is used to score a particular individual to give some indication the likelihood of that particular individual's desire to join a street gang. Insight into determining who might join a street gang before they actually do join can prove useful in reducing the number of active participants involved in street gangs, eventually diminishing the gangs themselves. Preventing an individual from joining a gang is likely to be easier than influencing an individual to leave a gang. The use of surveys, observations, or one-on-one interviews with individuals may be different methods in gathering the information needed to score each individual with the value hierarchy. Once these individuals are scored, trends could be recognized among individuals who possess a high likelihood of joining a gang, and different programs could be established in attempt to keep them from joining a street gang.

Operations research techniques can be used to aid in the allocation of scarce resources. In addition to the value model, an example allocation illustration will be provided. This illustration is offered to demonstrate a use of operations research in a public sector problem. The following section introduces the techniques to be demonstrated.

Knapsack Problem

Linear programming is an optimization problem used to maximize (or minimize) some linear function subject to some set of constraints (Winston, 2004). The objective function is typically comprised of decision variables that need to be determined. The constraint functions are on the use of the decision variables. This thesis will use a more specific type of linear programming known as the knapsack problem.

The knapsack problem is any integer program with only one constraint (Winston, 2004). In the binary knapsack problem each decision variable is assigned either a 1 or 0. The idea of the knapsack problem is to fill a knapsack with as many items as possible to maximize benefits under the constraint of not putting more than some specified weight in the knapsack. The general equation for developing knapsack problems is as follows (Martello & Toth, 1990: 2):

$$\text{Maximize} \quad \sum_{j=1}^{n} p_j x_j \tag{5}$$

$$\text{Subject To:} \quad \sum_{j=1}^{n} w_j x_j \leq L \tag{6}$$

Where: $x_j = 1$ if the item is placed in the knapsack and 0 otherwise

p_j = benefit from including item j

w_j = weight (or cost) of item j

L = limit on the weight (or budget) for knapsack

The knapsack problem is proven to be NP-hard; enumerative and approximate algorithms have been used to solve them (Martello *et.al.*, 1990). Many different approaches such as branch-and-bound, greedy heuristics, and dynamic programming algorithms can be used to solve the knapsack problem. This thesis used Frontline Premium Solver in Microsoft Excel to solve all of the knapsack problems. This Solver utilizes the branch-and-bound algorithm to solve these problems.

Summary

This chapter has discussed the effect street gangs have on children in society and the importance in reducing the number of children likely to join street gangs. Two approaches to modeling an "at risk" child likely to join a street gang have been proposed in this chapter and were implemented in this thesis. Chapter 3 discusses the development of an Ishikawa diagram and concludes with a conclusive model of an "at risk" child likely to join a street gang. This information, along with the expertise of a DM, is used to construct a value hierarchy that also models an "at risk" child likely to join a street gang.

III. Methodology

Overview

One single profile of an individual that will join a street gang is difficult to construct. Many different aspects affect a person's desire to join a street gang; no one, concise model will account for a specific individual but they can give an overview to guide judgement. In this thesis, two different models were developed and used to represent an individual likely to join a street gang.

The first model developed is based on the Ishikawa (fishbone) diagram approach. "A fishbone diagram visually presents the main profile areas, and allows for additional levels of detail to be developed as required" (Costin, 1994:177). The fishbone diagram developed here examines the profile of an "at risk" individual likely to join a street gang. It graphically outlines different indicators that detectives, investigators, counselors, or gang prevention programs consider when identifying "at risk" individuals. This model was primarily used as a brainstorming tool and fed necessary information to be used in the second model developed. It does, however, provide a concise overview to capture the key elements effecting "at risk" youths. A number of problem analysis approaches, while not applied in this study, are associated with the Ishikawa diagramming process (Evans & Lindsey, 1993:259-262). These approaches could be applied to the "at risk" youth problem in a community.

The next model was developed by using the technique of value focused thinking (VFT). "Value focused thinking is a way to channel a critical resource - hard thinking - to lead to better decisions" (Keeney, 1996:537-538). Using VFT, a value model was developed to assist in identifying "at risk" children likely to join a street gang. The

model does not determine whether or not that child will join a street gang, but rather suggests the individuals that are more susceptible to join a gang. This screening mechanism thus aids in reducing the number of identifiable children that gang prevention programs need to target. The value model was developed with an expert in the field of street gangs who currently works as a detective in gang prevention.

Fishbone Diagram

Chapter 2 has provided the necessary background and information needed to develop a fishbone diagram. The problem area of gangs and "at risk" youth has been addressed and deemed necessary to research. Step two presents the need for the problem to be defined and a title to be developed. The purpose for the fishbone diagram is to profile a potentially "at risk" individual that is likely to join a street gang. Steps three through five were used to brainstorm all possible indicators of an individual likely to join a street gang and organize them in an orderly fashion as outlined by Pyzdek (2001).

Based on the literature review and discussions with subject matter experts, the main underlying causes for an increased propensity of an individual youth to join a street gang are *Descriptive* traits, *Family* life, *Economic* influence, *Social* influence, and *Protection* and *Security*. Figure 3 gives the basic outline for the fishbone diagram and its main underlying causes. The following sections develop the second and third levels under these main causes and finish with the complete "At Risk Individual Profile."

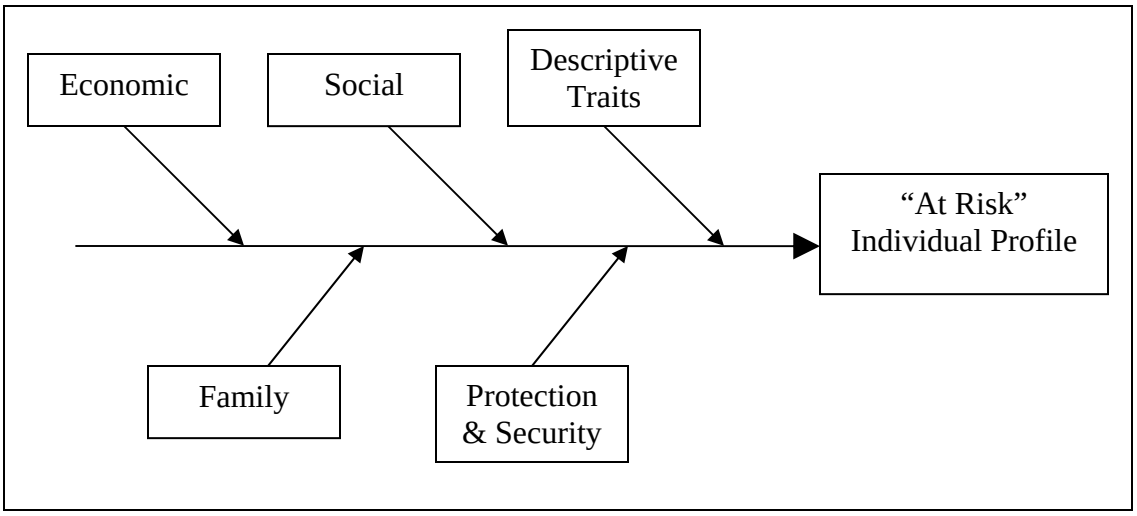


Figure 3. Basic Framework for "At Risk" Individual Profile

Descriptive Traits

Each individual is made up of three different descriptive traits that are common to all people. These three traits are a person's age, gender, and race/ethnicity. Historically, street gang members have fallen under specific categories for each of the three traits. However, it is important to note that not every gang member will fall under one category of each trait; rather the strength of a category can be dependent on the area of the country or area of a particular city in which they live. This fishbone diagram is constructed with the intention of looking at street gangs in America. Historical trends from the literature have been used to identify the underlying causes or trends of each trait.

Ages of street gang members can vary from extremely young (5 to 6 years of age) to 30 and beyond (Sanchez-Jankowski, 1991). However, Sanchez-Jankowski has also found that the older members are normally founders who guide newer participants and are generally not new members. Research has also found that adolescents will release themselves from any affiliation of a street gang as they become adults (Lasley, 1992). This information and other research imply that the appropriate age range of an "at risk"

individual likely to join a street gang would be between 5 and 18. Craig *et al*. (2002) found that the primary ages for joining a street gang were 10 to 14.

Males and females are both at risk for joining a street gang, given different circumstances. However, studies performed independently by Fagan (1990), Klein (1971), Maxson & Whitlock (2002), Miller (2001), and Moore (1991) have found that gangs are usually 10 to 38 percent female. This shows dominance in gender geared toward males being likely individuals to join a street gang. These authors also found that females do participate in criminal activity in gangs, but do it on a lesser level than males. Although female membership is less likely in a street gang, it cannot be overlooked (Klein, 2005).

Many gangs do exist in which a particular ethnic background is required for membership such as the White Supremacists; however, this fishbone analysis looks at the trends and historical proof of those individuals most likely to join a street gang in America. All races must be considered and could be dependent on the area of the country in which the gang prevention is taking place. Klein (2006) found that most of the street gangs are made up of Hispanics and African American, rather than Asians and Caucasians. Klein continues with the notion that Hispanics are more likely to join a gang than African Americans. Cummings (1993) agrees that Mexican and Puerto Ricans primarily make up street gangs, but states that "street gangs are territorially based…depending on the ethnic composition of the local neighborhood" (170).

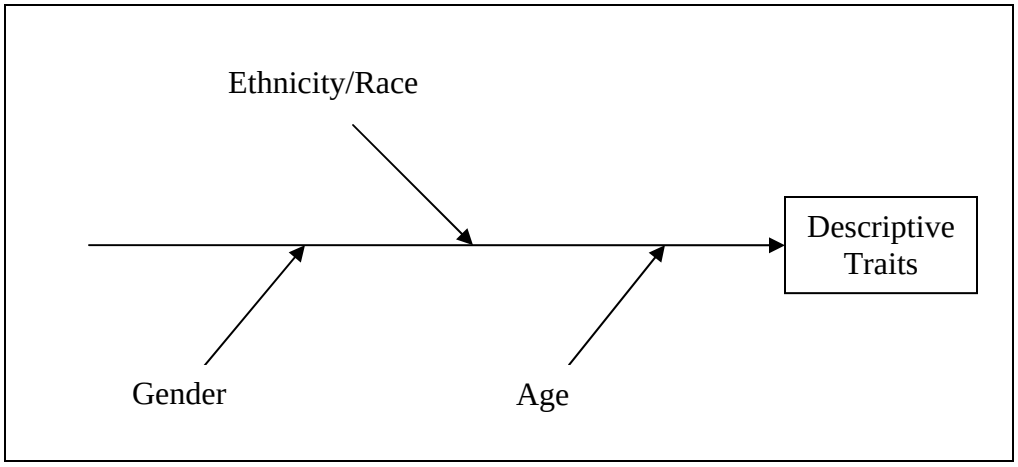


Figure 4. Descriptive Traits

Social Influence

An individual's surroundings and social habits can have a great effect on being considered an "at risk" youth. While looking at "at risk" individuals, investigators are primarily interested in a person's drug habits, criminal tendencies, and, in particular, a person's peers.

As of late, street gangs have gradually taken over the drug industry in the United States, attracting new gang members (Sanchez-Jankowski, 2003). It has been hypothesized that individuals might be interested in joining street gangs for one of two reasons: One could be to have an access to drugs (Sanchez-Jankowski) and the other would be the opportunity to sell drugs for funds (Fagan, 1989; Trojanowicz *et al*, 2001). In summary, if an individual is a user of drugs or has a history of trying to sell drugs, membership in a street gang is a likely possibility for the individual.

Criminal tendencies of an individual have an effect on an individual's desire to join a street gang. Research typically agrees with the notion that those individuals who commit crimes (non-drug related) are more likely to want to continue committing these crimes. Nafekh (2002) found that "gang members were more likely to have had previous

youth court involvement" (6) that stemmed from committing crimes. The Criminal Justice Research Center (2007) breaks up crimes into two different categories: Crimes committed against people and those committed against property. Individuals who find themselves committing either of these crimes tend to find their ways into these street gangs (Nafekh, 2002).

Peer pressure has a strong influence on what a youth might do in their life. Craig *et al*. (2002) found that males who had friends in gangs were more likely to join their gang. Often, current gang members will not be friends with those that are not members of their gang. Trends show that children that are aggressive tend to associate with other aggressive children (Cairns *et al.,* 1991). Examining who has friends in gangs may be an important indicator in determining who might join a street gang at some point.

Having friends in gangs is not the only way that peer pressure can affect an individual. According to Maslow (1951), feelings of acceptance are important to every human being. Much of the research done in the area of street gangs have found that adolescents will join street gangs to feel accepted, feel they are an important addition to a group, and feel that they now have a new family (Galinsky *et al*., 2002; Zimmerman *et al.,* 2004; Knox, 2001).

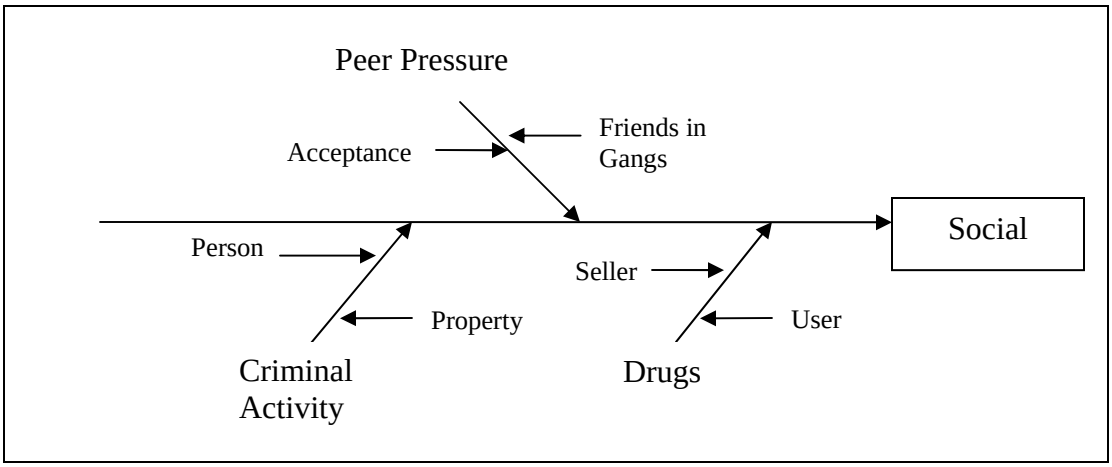


Figure 5. Social Influence

Economic Influence

Money is an issue for all individuals; it pays for the necessities of life but may also define a person's perceived position in a society. Normally, gang members come from low income areas due to the small amount of resources available (Sanchez-Jankowski, 2003). Two sources of income can exist in an individual's life: Personal income they earn themselves and income earned in the entire household. If an individual is working a minimum wage job, gangs can be an attractive alternative, offering the promise of fast and easy money far beyond what the individual can currently earn (Portes *et al*., 2001). Household income can have a great effect on the individual as well. If the family makes or has sufficient wealth or income to support the individual, their desire or need to reach out to illegal activities in gangs, at least for survival needs, is lessened. However, a poverty stricken household can easily drive the individual to alternative paths in order to gain income (Sanchez-Jankowski).

Along with personal and household income, perceived economic opportunity can hold influence on an individual's desire to join a street gang. According to Sanchez-Jankowski (2003), youths may see their parent's jobs negatively and may be driven to not

fall under the same circumstances. The youth may feel that their opportunity for achievement beyond their parents is unattainable unless they join a street gang. The lack of perceived economic opportunity can also be tied back into the individual living in an area with scarce resources. If one lives in a community where no one but the criminals earn more than a subsistence living, those criminals may become the role models for economic success.

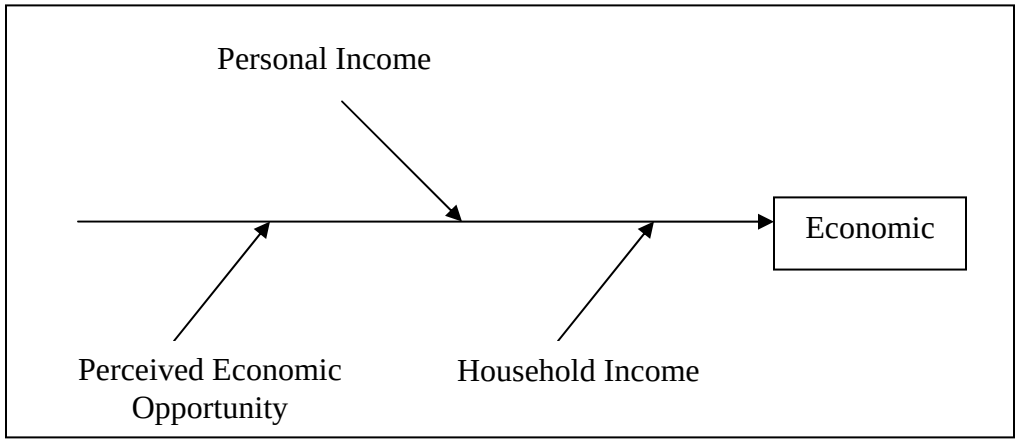


Figure 6. Economic Influence

Family Life

Family can have some of the most profound influence on an individual's desire to join a street gang. Broken homes can create a lack of role models in a child's life (Trojanowicz *et al*., 2001; Delaney, 2006). Negative occurrences at home and negative affiliations in the household can also have a dramatic effect on the child's upbringing. These effects are common among dysfunctional families (Hirschi, 1969).

A broken home can be caused by lack of family structure. No current research has found a direct correlation between a positive upbringing and being in a nuclear family; however, much of the research agrees that a broken home is an indicator for joining a street gang (Delaney, 2006). Family structure can consist of a nuclear family,

single parent family, blended family, or a foster home. Many smaller branches can be extended to account for third party guardians and homeless children.

Changes in the family structure can also lead to a broken home thus potentially leading to new gang recruits. Divorce, death, incarceration, and abandonment can all have negative effects on a child's upbringing (Delany, 2006; Yoder *et al*., 2003; Trojanowicz *et al*., 2001). These events, along with others, can lead to the child being in a blended or single parent family, or a foster home situation. Lack of family structure can lead a child to seek a new "family" within a street gang (Yoder *et al*., 2003).

The existence of drugs in the child's household can be a prominent indicator that the child will eventually use or sell drugs. This influence of drugs on the child can also increase violence and aggression within the child (Curran & Renzetti, 1994). Even if the child is not influenced to use or sell drugs, drug abuse by the parents can inhibit their ability to raise the child in a healthy environment (Dishion *et al.*, 2005).

Physical, mental, or sexual abuse can all have both physically and psychologically damaging effects on a child. Typically, females are affected (emotionally) more by the physical and sexual abuse and will seek out gangs for protection and acceptance (Delaney, 2006). It has also been found that those who are abused are likely to become abusers later in their lives (Yoder *et al*., 2003). Streets gangs can offer a way out of the abusive household and into an environment that promises to be free of abuse (whether it is, in fact, or not).

Gang affiliations within the immediate and extended family can also have a great effect on the child. Popular within the Mafia, male children will typically follow in the

steps of their father and join the organization when they come of age. A child might also join a gang to feel accepted by their family member (Zimmerman *et al*., 2004).

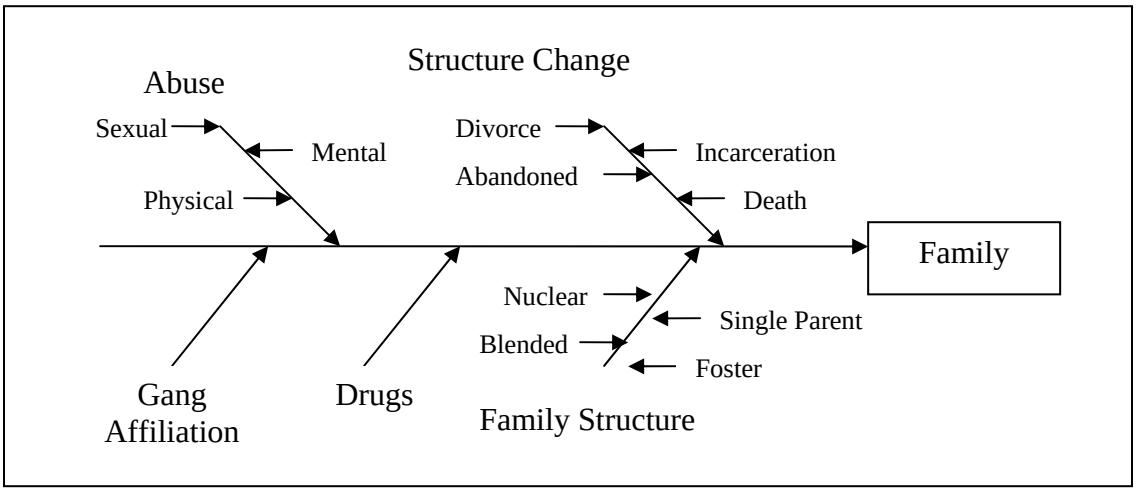


Figure 7. Family Life

Protection & Security

Survival, security, and protection are all commonly used words when discussing new recruits in street gangs. Protection could be necessary in many different situations with the most common situations being in the neighborhood, in the school, or in prison. An individual may have no desire to join a gang, but if local gangs in the neighborhood are feuding and a youth is not on a gang's side, they become the enemy (Delaney, 2006). Another circumstance could involve being bullied in school which leads to the individual to join a street gang so the bullying stops (Delaney, 2006 & Johnstone, 1983).

In terms of protection and security, incarceration can be the greatest reason an individual will join a street gang. One reason for joining a street gang in prison is for protection from other inmates (Delaney, 2006). A second reason would be to have a group to go to when released from prison that can help the ex-con assimilate back in the

social life (Hughes, 2006). Lastly, inmates might also join gangs in order to obtain drugs or other forms of contraband from other inmates or visitors.

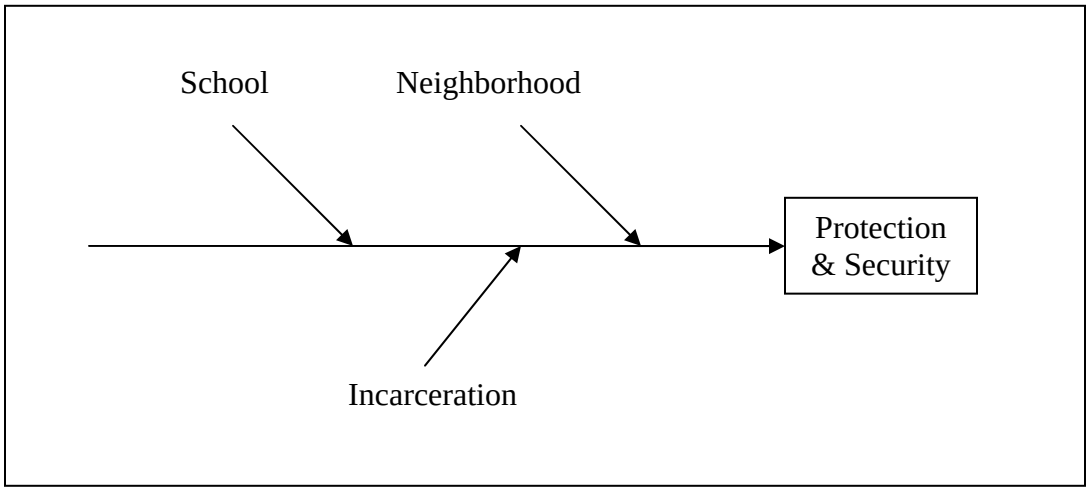


Figure 8. Protection & Security

At Risk Individual Profile

The five main indicators have been developed and are ready to be assembled into the main fishbone diagram, shown in Figure 9. This profile gives a quick summary of the indicators of someone that is potentially at risk and likely to join a street gang. Data could be collected on each of the five areas and determine how much effect each area might have on the entire profile. Additional items can be added to the fishbone diagram, if individual local conditions dictate such additions. The framework is robust and aids in identifying key areas and factors. This profile can be used as a visual aid for further research in the areas of "at risk" youth and street gangs. It also provides a useable framework to introduce new counselors, teachers, officers or parents to the effectors of youth at risk of joining a street gang. In addition, the Ishikawa diagram can be used in conjunction with other process improvement tools to aid in developing a plan to mitigate the youth at risk problem.

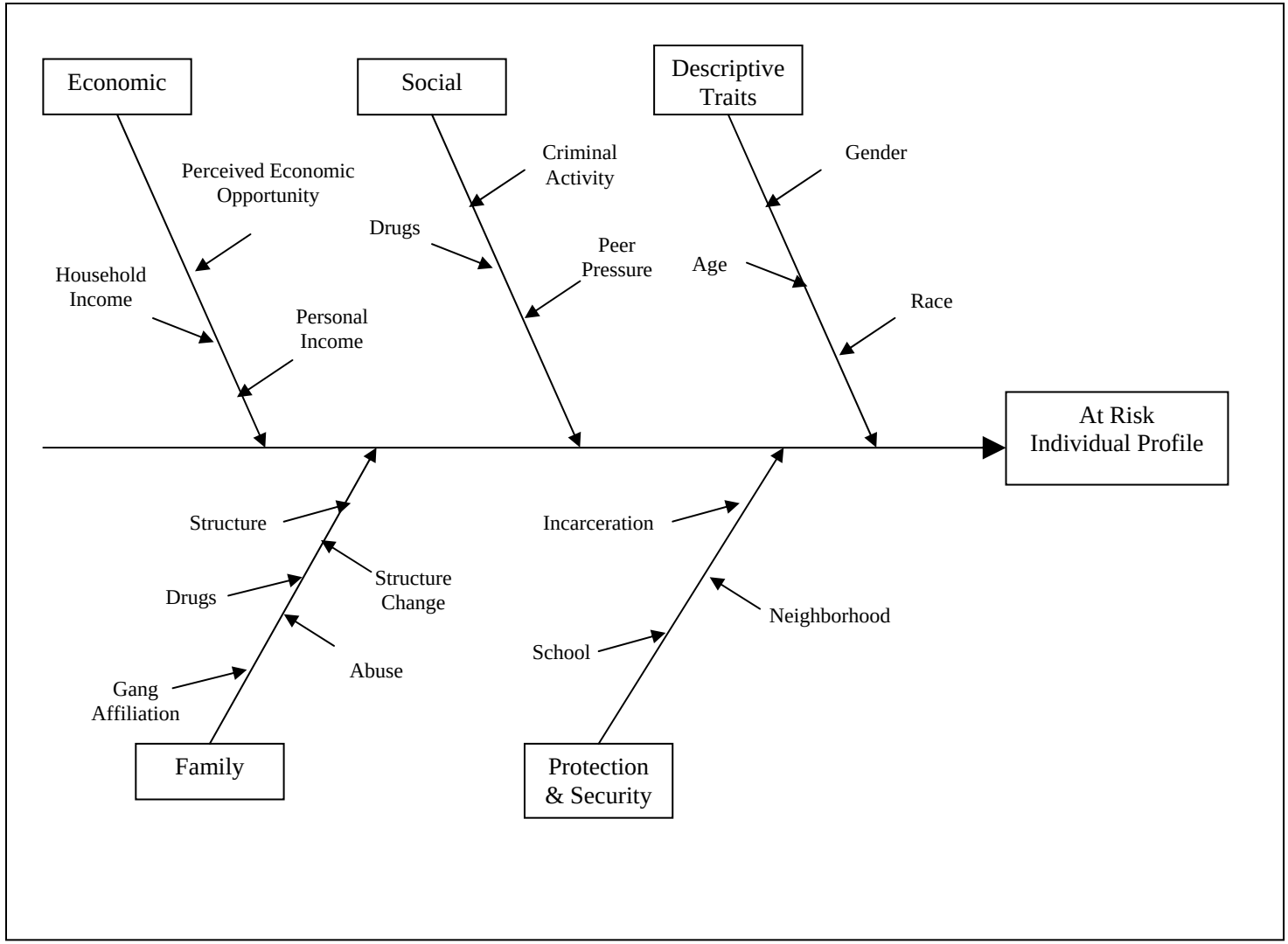


Figure 9. At Risk Individual Profile

Value Focused Thinking Approach

Several authors have different methods in their approach to VFT. The main idea is similar for all of the authors; only differences in some of the steps exist. The process used in this thesis follows Kirkwood (1997) and Shoviak's (2001) approach to Keeney's (1996) work in the area of Decision Analysis and VFT. Figure 10 shows the 10-step process flow chart developed by Shoviak which were used as the approach in this thesis. It is important to note that looping and feedback can occur between all steps.

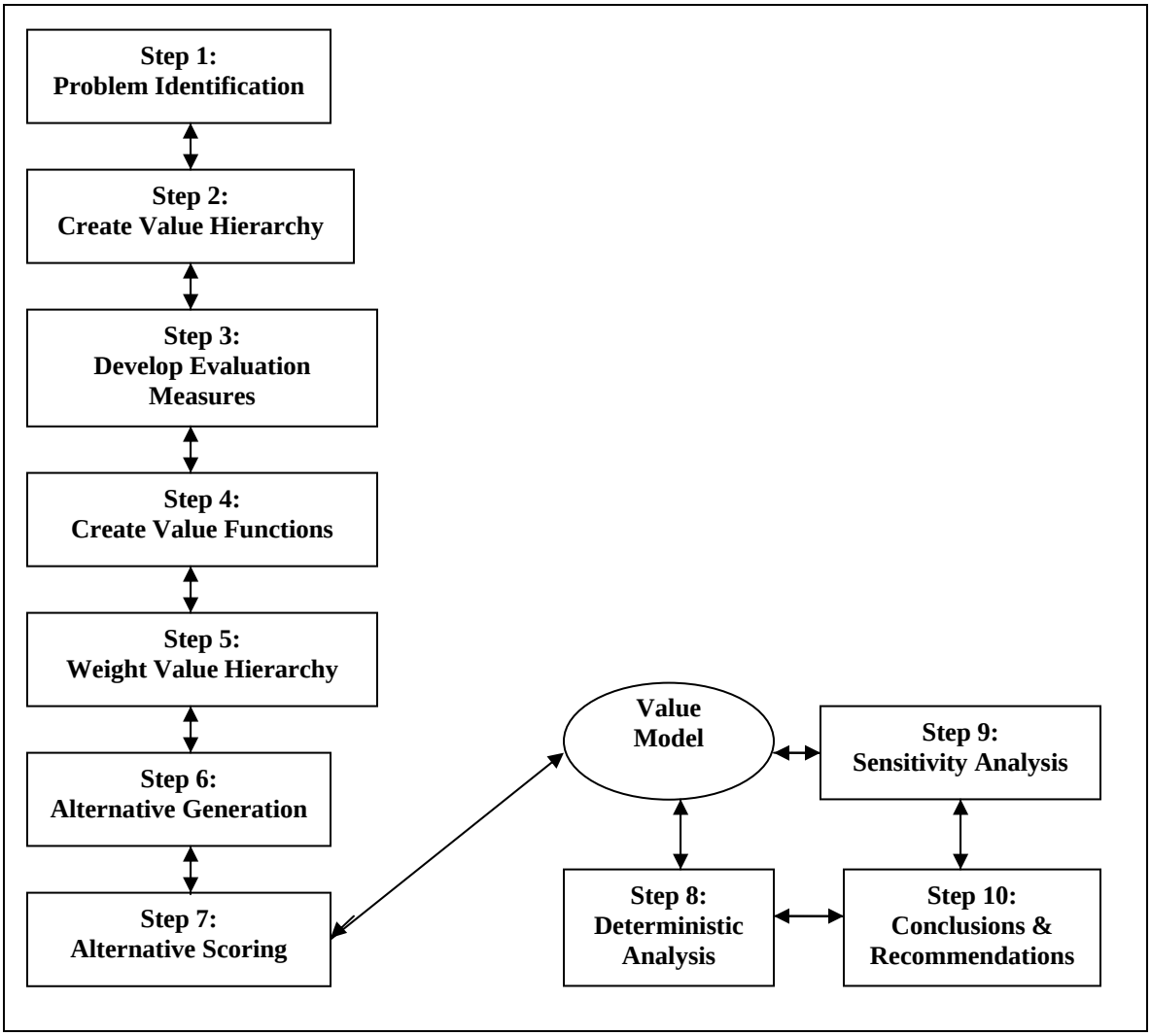


Figure 10. VFT 10-Step Process Flow Chart (Shoviak, 2001:63)

Step 1: Problem Identification

Essential in any decision is to correctly and precisely identify the problem that is to be studied. Without a clear definition of the problem, bad decisions can be made (Kirkwood, 1997:11). It is important to understand the problem in order to avoid answering the wrong question in the end. As discussed in Chapter 2 and presented in the Ishikawa diagrams previously, the problem area under study is youth entry into street gangs. More precisely, the objective of this thesis is to identify potentially "at risk" children that are likely to join a street gang.

Before moving on with the 10-step process, several assumptions need to be made. First, this problem considers children age 5-18 of any race and gender. The model also does not differentiate in age. Second, this model is constructed based on the expertise of a current police detective in charge of investigating gangs for Montgomery County in Ohio. This infers that some of the scales could be region specific and may need to be adjusted for different counties or states.

Step 2: Create Value Hierarchy

In the construction of a value hierarchy, the analyst solicits values from a particular decision maker interested in the decision. This process begins with brainstorming. During the brainstorming stage, the decision maker (DM) is asked to think of their "wish list" of what they value. After looking at their wish list, the DM is then asked to look at current problems, pitfalls, or consequences of the current situation. The DM is also asked to look at the decision from the different perspectives of those who might be affected by the decision (Kirkwood, 1997).

As discussed in Chapter 2, this list of values and ideas is then used to create affinity diagrams or other approaches such as the Ishikawa diagram. Affinity diagrams take large amounts of information and divide them into different groups of commonality (Kirkwood, 1997). Each group has a common term that associates all of the members within the group. These terms then become the top level or first tier of the value hierarchy. Sub-tiers are then created from the first tier until the fundamental objective (ultimate objective) is achieved by the DM (Kirkwood, 1997). It is important to note that all objectives on the lowest tier must be measurable with a single valued evaluation measure associated with the objective.

When creating a value hierarchy, there are five desirable properties to maintain: Completeness, nonredundancy, decomposability, operability and small size (Kirkwood, 1997:16-18). Some of these properties may seem intuitive, but prove to be extremely important to follow in order to develop a logical and correct hierarchy.

Completeness involves ensuring every tier adequately covers the concerns of the overall objective which is critical in having a complete hierarchy (Kirkwood, 1997:16). Every objective important to the DM must be included in the hierarchy to satisfy completeness. Another important aspect of the value hierarchy being complete is that each lowest level objectives contains an evaluation measure(s) that adequately defines the objective.

Nonredundancy means that “no two values in the same layer or tier should overlap” (Kirkwood, 1997:16-17). This idea assists in avoiding double counting, which can affect the scoring of alternatives and put more weight than intended on a value.

When discussing issues of decomposability, assuring preferential independence is typically the area where the most care must be taken. Simply, one value's single dimensional value function (SDVF) should not depend on the SDVF of another value. A SDVF is a function (exponential or piecewise linear) that assigns a value to each measure. The benefit of decomposability is that it allows for the use of an additive value function.

Operability in this context simply means the ability to be understood and carried out. It is important that the DM, stakeholders, and any others associated/affected by the decision are able to understand the value hierarchy. If everyone involved understands the value hierarchy, then fewer mistakes are made in the process. Typically, operability is most important when creating evaluation measures (Kirkwood, 1997:18).

A small hierarchy is more desirable in order to communicate it more easily to those involved with the decision and for economy of effect. It is also useful in determining indicators or important factors that exist within the hierarchy and decision context (Kirkwood, 1997:18-19).

In the construction of the gang hierarchy for this study, building on the literature search, the expertise of a detective responsible in the area gangs and sexual offenders for the Montgomery County Sheriff's Department was used. From the solicitation of ideas and values, four main areas were deemed important in identifying a potentially "at risk" child likely to join a street gang. The first area dealt with the child's family structure and stability in the household. The second area dealt with the neighborhood where the child resides. This area examines if gangs are present in the area, and if so, what kind of affect they have on the crime rate. The third area looked at is the child's sense of acceptance

within his/her group of friends and family. Finally, a child's perception of and desire for the gang's projection of a desirable "gangster" lifestyle can increase the likelihood they might join a street gang. This can stem from current income situations or from drug and criminal activity in which the child is involved. In summary, the top tier values are 1) Family Stability, 2) Protection & Security, 3) Acceptance, and 4) Lifestyle.

These four values are then extended into sub-tiers to conform to the completeness property. Family Stability is subdivided into 1) Abuse and 2) Family Structure. Abuse deals with the presence of any type of abuse (verbal, physical, mental, or sexual) that might be in the child's history and committed by a member of the household. Family Structure is further divided into 1) Current Structure and 2) Change in Structure. Current Structure examines the family type in which the child is currently living in. Change in Structure observes any loss of parents or guardians within the past year.

Protection & Security is only divided into one subgroup, Gang Violence. Gang Violence examines the number of gangs that are present in a particular neighborhood and the magnitude of their presence in terms of crime rates.

Acceptance is subdivided into 1) Family Gang History and 2) Peer Pressure. Family Gang History deals with any past or present affiliation a current family member (first cousin or closer) might have with a street gang. Peer Pressure is further subdivided into 1) Current Friends Involved and 2) Need for Friends. Current Friends Involved considers if the child has any friends currently involved with a street gang. The previous notion ties back to the idea that aggressive children associate themselves with other aggressive children. Need for Friends investigates whether or not the child has feelings

of being an outcast or outsider in his/her current social surrounding. Feeling alone can lead to the desire to join a gang for companionship and a sense of belonging.

Lifestyle is subdivided into 1) Financial Stability, 2) Addiction, and 3) Criminal Activity. Financial Stability examines the current income level of the household. Lower income levels have historically proven to produce new gang recruits. Addiction looks at any type of drug or alcohol addiction that the child may have. It considers both a user and seller of drugs. Criminal Activity follows any criminal behavior expressed by the individual. Criminal behavior in this context examines violent crimes that are non-drug related. Violent crimes usually consist of burglary, murder, grand theft, and violence. If an individual steals money for drugs, this is not considered a violent crime, but rather a petty crime.

These four values and their subgroups all make up the value hierarchy for the gang model. The five desired properties of a value hierarchy are also achieved by this hierarchy. Arguments might be made that more values might be incorporated; however, based on the expertise and desire of the DM for this study, this hierarchy has been deemed sufficient and complete. Figure 11 displays the value hierarchy for the gang model in its entirety. Table 10 in the appendix gives a summary for the definition of all the values associated in this hierarchy.

Step 3: Develop Evaluation Measures

Following the construction of the value hierarchy, each value on the lowest tier must have a single dimensional evaluation measure(s) that best measures the associated value. The four different types of evaluation measures such as natural, constructed, direct, and proxy, were discussed in Chapter 2. The DM was asked to associate an

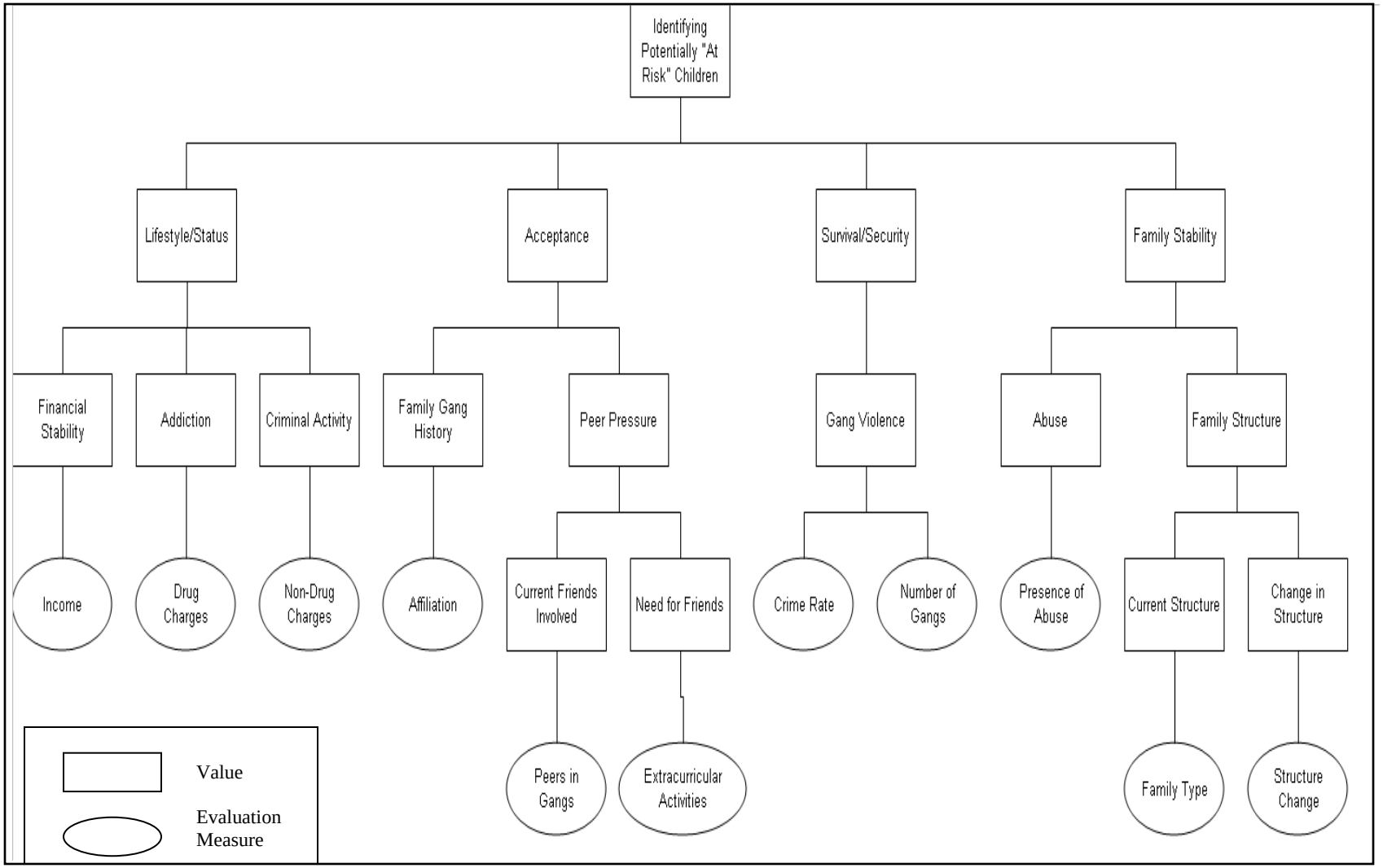


Figure 11. Value Hierarchy for Identifying Potentially "At Risk" Children

appropriate evaluation measure for each lowest tier value. These evaluation measures were to be items in which the detective or school officials would know or be able to uncover about each child and their family. Once the measure was defined, ranges were placed on each measure to determine the bounds.

For the gang model in this thesis, Table 4 displays a summary of all the evaluation measures for each lowest tier value. Along with the evaluation measure is the least preferred and most preferred values of each measure. The constructed measures will be more detailed in the next section as well as in the Appendix A.

Table 4. Evaluation Measures

Value	Evaluation Measure	Type	SDVF	x_0	x*
Financial Stability	Income of surrounding neighborhood	Natural Proxy	Decreasing Exponential	150000 +	0
Addiction	Number of drug charges in household	Natural Proxy	Categorical	0	3 or more
Criminal Activity	Number of violent crime charges of child	Natural Proxy	Categorical	0	2 or more
Family Gang History	Gang affiliation of family member	Constructed Direct	Categorical	No	Yes
Current Friends Involved	Number of peers in a gang	Natural Proxy	Categorical	0	3 or more
Need for Friends	Number of extracurricular activities involved in	Natural Proxy	Categorical	0	5 or more
Gang Violence	Number of gangs in city (or community)	Natural Direct	Categorical	0	10 or more
Gang Violence	Estimated crime rate responsible by gangs (percentage)	Natural Direct	Increasing Exponential	0	100
Abuse	Report or suspicion of abuse in household	Constructed Direct	Categorical	None	Reported
Current Structure	Child's family type	Constructed Direct	Categorical	Mother/ Father	Foster
Change in Structure	Number of parents or guardians lost in last year	Natural Direct	Categorical	0	2

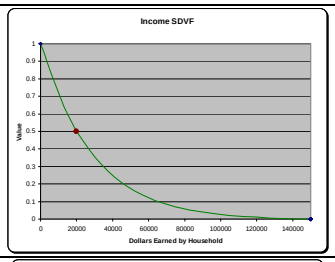
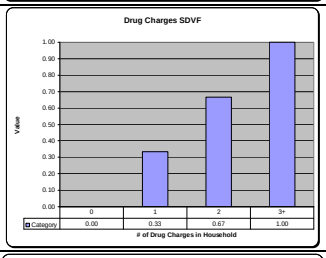
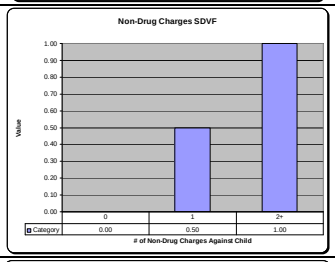
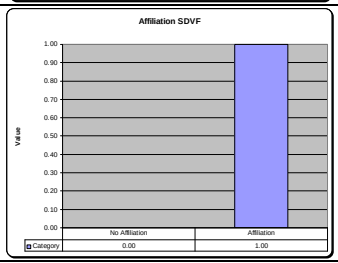
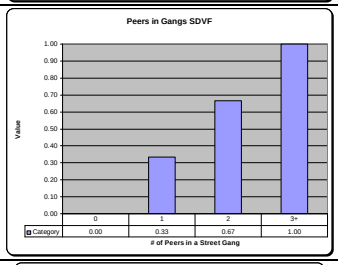
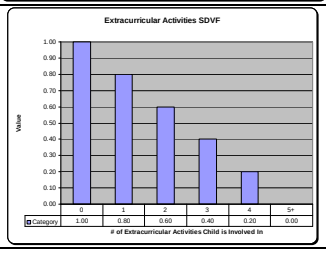
Step 4: Create Value Functions

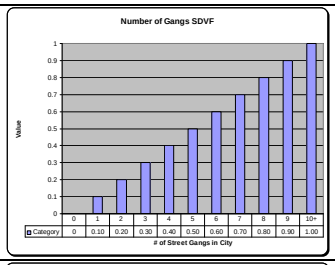
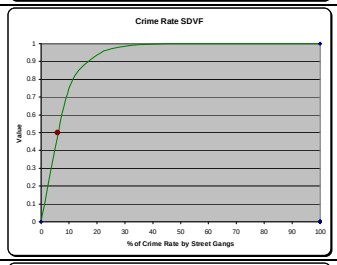
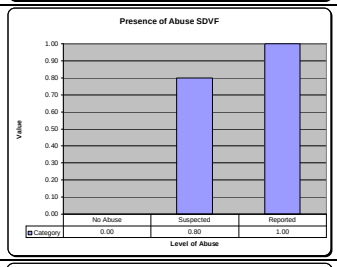
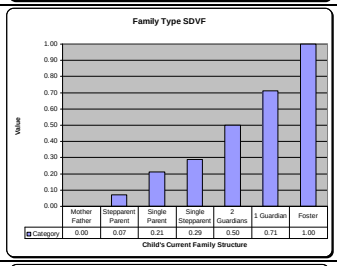
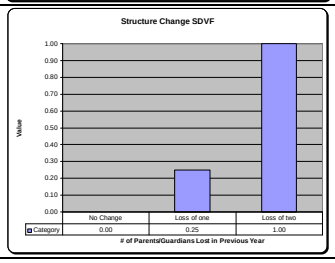
Single dimensional value functions (SDVFs) allow the analyst and decision maker to assign values between 0 and 1 on any given input from the evaluation measures. Typically a 0 is assigned to the least preferred value, 1 is assigned to the most preferred value, and the rest of the values fall somewhere in between. Two different procedures exist in creating value functions; one results in a piecewise linear function and the other an exponential function. "While the use of one may result in a somewhat different specific shape, the difference is not of practical significance" (Kirkwood, 1997:61).

Chapter 2 developed the knowledge on creating piecewise linear function and exponential functions. Value increments were important in creating the piecewise linear functions as described in Kirkwood (1997:64). For the exponential functions, only three points were necessary; the bounds and a midpoint. Kirkwood (1997:65) and Chapter 2 outlines the necessary equations for developing values within the bounds provided by the DM

In the gang model for this study, one weakness is that some of the SDVFs are discrete measures. More continuous measures, if available, would be desirable to avoid using subject matter experts (SMEs) in constructing scales and account for a large number of value increments. After discussing all of the evaluation measures with the DM and SMEs, the SDVFs were created for each evaluation measure. Table 5 shows a quick summary of all the SDVFs. A more detailed explanation of these SDVFs, is given in Appendix A.

Table 5. SDVFs for each Evaluation Measure

Evaluation Measure	SDVF	Type
Family Income		Exponential Decreasing
Household Drug Charges		Categorical Increasing
Youth's Non-Drug Charges		Categorical Increasing
Affiliation		Categorical
Peers in Gangs		Categorical Increasing
Extracurricular Activities		Categorical Decreasing

Number of Gangs		Categorical Increasing
Crime Rate		Exponential Increasing
Presence of Abuse		Categorical
Family Type		Categorical
Structure Change		Categorical Increasing

Step 5: Weight Value Hierarchy

Weighting the hierarchy allows the user to determine how much effect each value has on the overall decision. To determine the local weights for the different values, the use of "swing" weighting is recommended. While performing swing weighting, the DM is asked to compare two values against one another. The DM is then asked to swing each

value from its least preferred to most preferred, and determine which is more important. After determining which is more important, the DM is asked to associate a number indicating how much more important it is, similar to value increments in the evaluation measures. Values are compared within the same tier and each tier's weights sum to 1.

Global weights are necessary to determine how much effect each lowest tier value has on the overall objective. To obtain the global weights, the weight of the lowest tier value (which always sum to 1) is multiplied by the local weights directly above it in the hierarchy. In the gang model example, the local weight for Family Stability would be multiplied with Lifestyle to obtain the global weight for Income. All of the lowest tier weights must add up to 1 in order for the process to be done correctly. Table 6 shows the global weights for each of the lowest tier values.

Table 6. Global Weights

Value	Global Weight
Financial Stability	.168
Addiction	.024
Criminal Activity	.120
Family Gang Affiliation	.268
Current Friends Involved	.036
Need for Friends	.009
Number of Gangs	.031
Crime Rate	.031
Abuse	.045
Current Structure	.039
Change in Structure	.229

As seen by the global weights obtained, Family Gang History was judged to have the greatest effect on the overall objective/decision. Children scoring yes for the associated value would see a substantial increase in their score compared to other values. The other large value that stands out is Change in Structure. The DM, after viewing these weights, agreed with the notion that these two measures have the greatest effect on a child

potentially being at risk and likely to join a street gang in his area of operations. It is important to note that the weighting is specific to the DM's experience and judgment and could change based on a different DM's opinion without affecting the hierarchy.

Step 6: Alternative Generation

For this study, a comprehensive, but artificial, list of children representing Montgomery County was created. A real list of juveniles cannot be used due to confidentiality of information and privacy acts requirement. However, data was collected from national surveys for the 17 cities of Montgomery County. The different statistics collected represented most of the values accurately. However, the combination of the different values for each synthetic child is random and may not represent the true population accurately.

To create the data set, statistics on Montgomery County were collected from several public sources. These sources included US census data (2000), surveys performed on Montgomery County from outside resources (ODOD, 2000; DDN, 2007; CJRC, 2001), and information given by the decision maker.

US census data (2000) provided information on each of the 17 cities of Montgomery County regarding number of children that are 5 to 18 years of age (# of alternatives), percentages of children from different income brackets (income), and percentages of family types experienced by children (family type and structure change). The synthetic children were then created using a uniform random distribution to produce a specific income status, family type, and family loss situation. Consistency checks were implemented when dealing with the family type and family loss situation. It was important for consistency that a child from Mother/Father homes did not lose any

parents/guardians and those children from single parent families did not lose more than two parents in the last year.

Independent surveys collected information on number of violent crime (non-drug) and drug charges for the city of Dayton (CJRC, 2001). The violent crime and drug charges for the other cities were created based on the proportion of children living in an income below $25,000 compared with Dayton. Once the number of charges in each area was determines, children were given a uniformly distributed random number of charges (either ranged from one to two or one to three). While the approach could be altered in a different perspective, research on crimes in low income areas was deemed consistent enough to proportion the percentage of violent crime and drug charges based on low income.

An independent survey conducted on Montgomery County investigated the number of abuse (presence of abuse) reports or suspicion (DDN, 2007). The types of abuse considered were sexual, physical, or verbal. The numbers were not divided up by cities, so the approach taken to simulate Montgomery County was to distribute the numbers by population in each city. 4000 reports and suspicions were documented and divided among the 17 cities based on population in each city. This decision was based, in part, due to the lack of connection between income or other variables and the likelihood that abuse exists in the home. Since the value scores for reported abuse and suspected abuse are close, the 4000 documented occurrences were randomly assigned to be either reported or suspected.

Knowledge provided by the decision maker helped determine the percentages of children who have peers in gangs and at least one family member in a gang. For peers in

gangs, the detective stated that there is a 30 percent chance that a child has a friend(s) in a gang. For family members in a gang, there is a 35 percent chance that a child has a family member in a gang. These percentages were multiplied by the number of children in each city to give a simulation of the number of children affected in each of these areas.

Information on crime rate and the number of gangs in each city was the most difficult number to ascertain. Due to the policy of not discussing open cases, the only number that could be provided by the detective is that 27 street gangs exist in Montgomery County. The detective could not discuss the locations of these gangs, but rather pointed out several "problem" areas that are well known to the citizens of Montgomery County. Based on the information provided and the proportion to low income, a specific number was given to each city with the total sum being 27. To estimate the crime rate responsible by gangs, the number of gangs in the city was multiplied by .01 to establish a percentage. Again, actual figures could be used, if available, in an official study by a community.

The last evaluation measure to be considered was the number of extracurricular activities in which each child is involved. Information on this area could not be found in any public surveys or documents. To obtain a specific number, each child was given a uniformly generated random number of extracurricular activities ranging from 0 to 5 which he or she participates. No concrete evidence from literature review suggested whether or not (or how many activities) a child might be involved with outside of school.

Despite the representation not being perfect, the alternatives approximate the children of Montgomery County well. If more accurate information is available, this information can be easily substituted into the model for evaluation. Children can be

distinguished by city in hopes to examine particular areas in need of special attention. However, the location in each city is not specified in this data set. Based on available information, the inputs for the 83,004 synthetic children that approximate Montgomery County were created.

Step 7: Alternative Scoring

Each notional child was scored for each of the randomly generated inputs. There is no missing data and all the notional children received a score between 0 and 1. The uniform distribution in Microsoft Excel was used to create the alternatives and determine the scores for each child. The scores were divided up by the 17 cities in Montgomery County.

Step 8: Deterministic Analysis

The value model developed used an additive model to determine each alternative's score. These scores are then ranked from highest (most "at risk") to lowest (least "at risk"). It is important to note that a numerical difference in two alternatives' scores does not make one a certain amount "better" than the other. The scores rank how much of the DM's value of being "at risk" is displayed by the particular youth. A deterministic analysis of potential resource allocation is discussed in detail in Chapter 4.

Step 9: Sensitivity Analysis

Sensitivity analysis can be conducted on the alternatives by adjusting the weights of the values in order to determine any change in the ranking. Sensitivity analysis also indicates the robustness of the weights. This is important if there is "a matter of disagreement among the various stakeholders for a particular decision" (Kirkwood, 1997:82). To perform sensitivity analysis, one weight is chosen to adjust

from 0 to 1 while the others remain proportional to the weight changed. This allows the user to notice when one alternative(s) becomes better or worse than another alternative(s). More of the sensitivity analysis for the gang model will be discussed in Chapter 4.

Step 10: Conclusions and Recommendations

All conclusions and recommendations for the gang value model are presented in Chapter 5. Other suggestions or final remarks are also presented in that chapter.

Other Operations Research Approaches

To further demonstrate the potential use of operations research to the question beyond the Ishikawa diagram and the value model, an allocation model was solved. The illustrative youths and the information gained from the value model were used to determine resource allocation via a knapsack model. Six notional gang prevention programs were developed (each with an associated notional cost and notional benefit) and the knapsack problem was solved to allocate the six different programs within Montgomery County in order to maximize the anticipated reduction of "at risk" children in the county. Results for six different problems are presented in Chapter 4; Chapter 5 presents the best assignment of programs in Montgomery County found by the notional example. Chapters 4 and 5 provide sensitivity analysis to determine the amount of cost to spend on gang prevention programs in order to achieve a desired percent reduction in "at risk" children.

Summary

This chapter has provided a working value model to evaluate potentially "at risk" children likely to join a street gang. The model was developed with inputs from a

detective working in the area of street gangs for Montgomery County in Ohio. This model can be adjusted (values or weights) for different regions of the country, as appropriate. The methodology for generating a synthetic data set to evaluate the model was also discussed. This synthetic data set was implemented into the model and scores were generated.

The information gained from the value model was incorporated into a knapsack problem in aiding in creating constraints. The results obtained from the knapsack problem provide a notional quantitative analysis regarding the placement and types of gang prevention programs required by Montgomery County. This notional example is provided to illustrate how operations research techniques might be used and should not in any way be considered an actual analysis for Montgomery County. With proper, real world data, such an analysis could be conducted, however, Chapter 4 analyzes these results and Chapter 5 provides the conclusions and recommendations following the data analysis.

IV. Results and Analysis

Overview

This chapter illustrates the results of the value model for Identifying Potentially "At Risk" Children. This model is demonstrated on notional data generated to reflect every child living in Montgomery County. The entire notional data set was split into the 17 cities which make up Montgomery County. The scores obtained from the model for the illustrated sample provided insight into the location of the most "at risk" children, as well as areas that pose a higher probability of gang existence. Based on the synthetic data set, 6 hypothetical gang prevention programs were considered for the 17 cities in hopes of reducing the number of "at risk" children and consequently diminish the number of street gang members. Different hypothetical scenarios and portfolios are discussed with regards to the different gang prevention programs. These analyses, while notional, are presented to illustrate some of the potential uses of operations research to the problem of "at risk" youth.

Model Results

Chapter 3 discussed the method for generating notional data for Montgomery County. It is important to note that in the remainder of this thesis, the data is to be considered notional; however, real data, with proper authority, could be substituted in the model for more accurate results. The synthetic data consisted of 83,004 children among 17 cities in Montgomery County. Each child was randomly designated a set of raw attributes for each of the evaluation measures discussed in Chapter 3. The model in which these scores are implemented is repeated below in Figure 12 for reference. A sample of the raw attributes is given below in Table 7. The table shows a mixture of

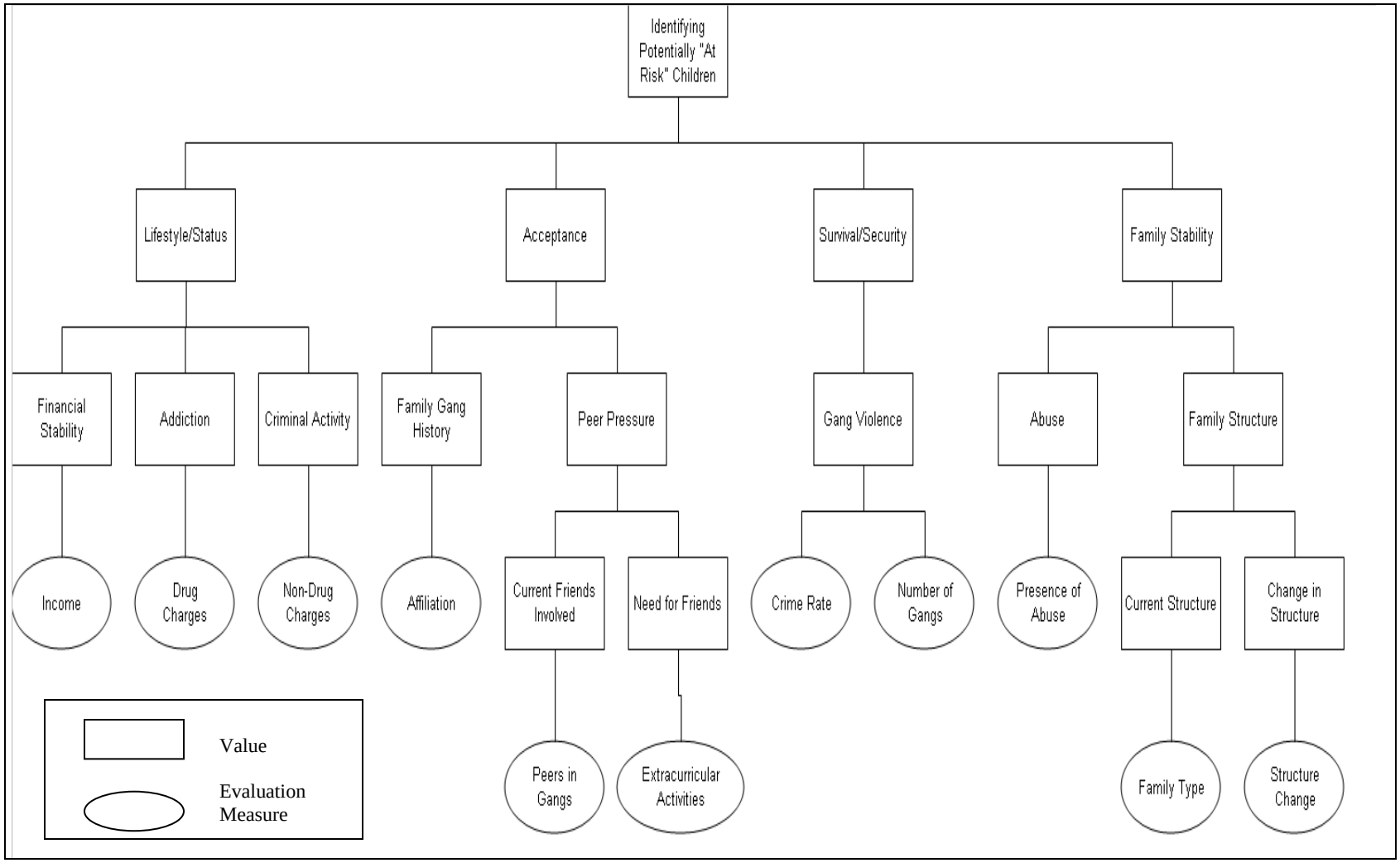


Figure 12. Value Hierarchy

children from different cities even though the city from which the child is from is not expressed in the table.

Table 7. Raw Attributes for Selected Alternatives

Child	Income	Drug Charges	Non Drug	Affiliation	Crime Rate	Number of Gangs	Presence of Abuse	Peers in Gangs	Extra Activities	Family Type	Structure Change
27897	2205	0	2	Affiliation	10	10	No Abuse	0	0	1 Guardian	Loss of two
16811	16595	0	2	Affiliation	10	10	Suspected	3	0	Single Parent	Loss of two
12485	2153	0	1	Affiliation	10	10	No Abuse	3	0	Foster	Loss of two
4345	2921	0	2	Affiliation	10	10	No Abuse	0	1	2 Guardians	Loss of two
23863	586	0	2	Affiliation	10	10	No Abuse	0	4	Stepparent/Parent	Loss of two
17097	3064	0	2	Affiliation	10	10	No Abuse	0	4	Single Parent	Loss of two
22029	12617	0	2	Affiliation	10	10	No Abuse	2	5	1 Guardian	Loss of two
22990	7337	0	2	Affiliation	10	10	No Abuse	0	5	2 Guardians	Loss of two
7666	7676	0	0	Affiliation	2	2	No Abuse	2	3	Single Stepparent	Loss of two
8208	1753	0	0	Affiliation	2	2	No Abuse	0	2	Stepparent/Parent	Loss of two
7317	10126	0	0	Affiliation	2	2	No Abuse	3	1	Stepparent/Parent	Loss of two
1051	15175	0	0	No Affiliation	0	0	No Abuse	0	0	Single Parent	Loss of two
1410	17281	0	0	No Affiliation	0	0	No Abuse	1	0	Stepparent/Parent	Loss of two
1559	150000	0	0	Affiliation	0	0	No Abuse	0	0	Single Stepparent	Loss of one
621	36525	0	0	No Affiliation	0	0	No Abuse	0	5	Stepparent/Parent	Loss of one
280	40437	0	0	No Affiliation	0	0	No Abuse	0	1	Stepparent/Parent	Loss of one
3	13933	0	0	No Affiliation	0	0	No Abuse	0	4	Stepparent/Parent	No Change
614	37648	0	0	No Affiliation	0	0	No Abuse	0	3	Stepparent/Parent	Loss of one

Once the raw attributes for all 83,004 children were created, these scores were imported into the value model outlined in Chapter 3. To evaluate the raw attribute scores, Microsoft Excel was used. Excel was chosen because it is readily available to detectives and/or investigators and it is relatively easy to use and understand. Table 8 gives the value scores (from the same sample in Table 2) for each evaluation measure.

Table 8. Value Scores for Selected Alternatives

Child	Income	Drug Charges	Non Drug	Affiliation	Crime Rate	Number of Gangs	Presence of Abuse	Peers in Gangs	Extra Activities	Family Type	Structure Change
27897	0.9264	0	1	1	0.7506	1	0	0	1	0.7100	1
16811	0.5620	0	1	1	0.7506	1	0.8000	1	1	0.2100	1
12485	0.9281	0	0.5000	1	0.7506	1	0	1	1	1	1
4345	0.9037	0	1	1	0.7506	1	0	0	0.6700	0.5000	1
23863	0.9799	0	1	1	0.7506	1	0	0	0.0600	0.0700	1
17097	0.8992	0	1	1	0.7506	1	0	0	0.0600	0.2100	1
22029	0.6454	0	1	1	0.7506	1	0	0.6667	0	0.7100	1
22990	0.7754	0	1	1	0.7506	1	0	0	0	0.5000	1
7666	0.7663	0	0	1	0.2425	0.2000	0	0.6667	0.1700	0.2900	1
8208	0.9411	0	0	1	0.2425	0.2000	0	0	0.3900	0.0700	1
7317	0.7038	0	0	1	0.2425	0.2000	0	1	0.6700	0.0700	1
1051	0.5905	0	0	0	0	0	0	0	1	0.2100	1
1410	0.5488	0	0	0	0	0	0	0.3333	1	0.0700	1
1559	0	0	0	1	0	0	0	0	1	0.2900	0.2500
621	0.2800	0	0	0	0	0	0	0	0	0.0700	0.2500
280	0.2440	0	0	0	0	0	0	0	0.6700	0.0700	0.2500
3	0.6166	0	0	0	0	0	0	0	0.0600	0.0700	0
614	0.2692	0	0	0	0	0	0	0	0.1700	0.0700	0.2500

Each of these alternatives' scores were multiplied by the global weight of each evaluation measure given in Table 6. These weighted scores (of the same sample) are given below in Table 9. Once completed, the value scores were summed for each

alternative to give the overall value score or "at risk" score. This normalized score was always between numbers 0 and 1. For this model, a number scoring close to one suggests that child as being more "at risk" for joining a street gang. Scores close to zero correspond with the child being less "at risk" for joining a street gang. Thresholds (points at which any child scoring lower than the threshold would be of limited concern when discussing street gangs) could be made at any value, depending on the expertise of the detective or as more information about "at risk" children and street gangs was developed. Some insight as to these thresholds might be gained by scoring youths already in gangs and examining their scores. Such a process, carried out on actual data from real gang members could also aid in validating the model. Table 10 shows the overall value score for the same sample subset of 18 synthetic youths.

Table 9. Weighted Scores for Selected Alternatives

Child	Income	Drug Charges	Non Drug	Affiliation	Crime Rate	Number of Gangs	Presence of Abuse	Peers in Gangs	Extra Activities	Family Type	Structure Change
27897	0.1559	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0000	0.0089	0.0272	0.2296
16811	0.0946	0.0000	0.1202	0.2679	0.0235	0.0313	0.0357	0.0357	0.0089	0.0080	0.2296
12485	0.1562	0.0000	0.0601	0.2679	0.0235	0.0313	0.0000	0.0357	0.0089	0.0383	0.2296
4345	0.1521	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0000	0.0060	0.0191	0.2296
23863	0.1649	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0000	0.0005	0.0027	0.2296
17097	0.1513	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0000	0.0005	0.0080	0.2296
22029	0.1086	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0238	0.0000	0.0272	0.2296
22990	0.1305	0.0000	0.1202	0.2679	0.0235	0.0313	0.0000	0.0000	0.0000	0.0191	0.2296
7666	0.1289	0.0000	0.0000	0.2679	0.0076	0.0063	0.0000	0.0238	0.0015	0.0111	0.2296
8208	0.1584	0.0000	0.0000	0.2679	0.0076	0.0063	0.0000	0.0000	0.0035	0.0027	0.2296
7317	0.1184	0.0000	0.0000	0.2679	0.0076	0.0063	0.0000	0.0357	0.0060	0.0027	0.2296
1051	0.0994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0089	0.0080	0.2296
1410	0.0923	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0119	0.0089	0.0027	0.2296
1559	0.0000	0.0000	0.0000	0.2679	0.0000	0.0000	0.0000	0.0000	0.0089	0.0111	0.0574
621	0.0471	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0574
280	0.0411	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060	0.0027	0.0574
3	0.1038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0027	0.0000
614	0.0453	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0027	0.0574

Table 10. Overall Scores

Child	Score
27897	0.8643
16811	0.8553
12485	0.8513
4345	0.8495
23863	0.8404
17097	0.8322
22029	0.8319
22990	0.8220
7666	0.6766
8208	0.6758
7317	0.6741
1051	0.3459
1410	0.3454
1559	0.3453
621	0.1072
280	0.1071
3	0.1070
614	0.1069

A few of these examples were selected for a more in-depth understanding behind their weighted and overall scores. Children 27897, 7666, 1051, and 621 were used to illustrate the model results. Figure 13 graphically displays the outputs seen in Table 8 and Table 10. It also adds the ideal child that would be most "at risk" and likely to join a street gang.

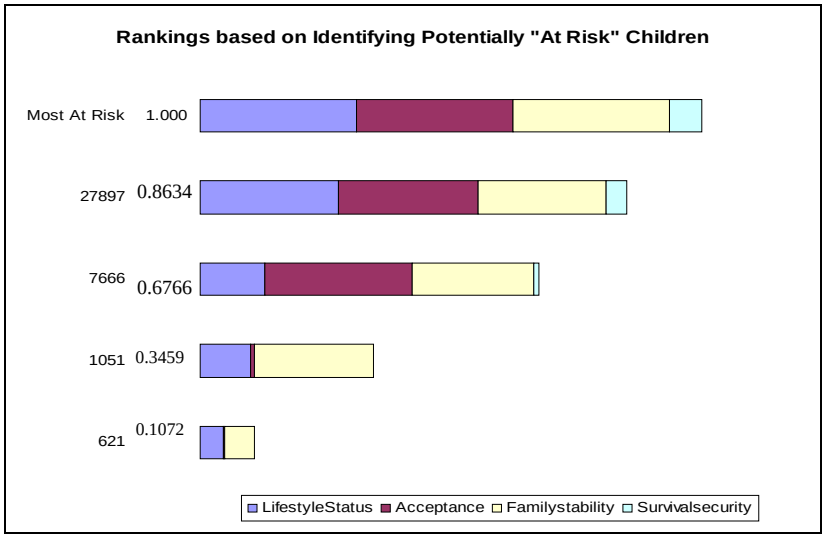


Figure 13. Scores for 4 selected children

As seen in Table 8 and Figure 13, Child 27897 scored the maximum for every evaluation measure except Drug Charges, Crime Rate, Abuse, and Peers in Gangs. Given the weighting as specified by the decision maker, the measures for which this notional child scored high on are the ones weighed the highest in the value hierarchy. This leads to the score of .8643 for this child. The model indicates that Child 27897 is likely to be "at risk" for joining a street gang. Compared to the scores of others, this is extremely high and this notional child should be flagged as "at risk" and in need of further attention.

Child 7666 only scored high, according to Table 8 and Figure 13, for evaluation measures Affiliation and Structure Change. However, this child scored high on a few other evaluation measures, driving this child's overall score to be .6766. This score indicates the child holds more than half the value of being an "at risk" child likely to join a street gang. While not ranked as high as Child 27897, Child 7666 still exhibits "at risk" potential.

Child 1051 adversely scored only on four evaluation measures: Income (1), Extracurricular Activities (1), Family Type (.21) and Structure Change (1). The Structure Change evaluation had the greatest affect on this child with the other evaluation measures adding minor influence to the child's "at risk" factor. The overall score for Child 1051 is .3459 which corresponds to the child only achieving nearly one-third of the overall value for being "at risk." Compared to the two previous children, Child 1051 is in a better situation for not being likely to join a street gang. However, further analysis on specific threshold levels is required to determine the child's actual status.

Finally, Child 614 only scored minor values on three of the evaluation measures. Due to the small nature of the values, Child 614 only scored a .1069 for his/her overall

score. Out of all four children, the model suggests Child 614 is least likely to join a street gang. While individual specific situations are always present, the model suggests that major changes would probably need to occur in this child's life for him/her to become likely to join a street gang.

As seen with these four children, scoring high in Affiliation and Structure change produces nearly half of the value of the hierarchy. These two evaluation measures are important indicators when discussing children being "at risk" to join a street gang. The influence of these two evaluation measures may change based on locality or magnitude of presence of street gangs in the area.

Sensitivity Analysis

Traditionally, sensitivity analysis is conducted on the weights to determine changes in alternative choices. Here, the synthetic youths clearly are *not* alternatives. The sensitivity analysis, instead, suggests the robustness of a child's score to the weights used. This initially implies areas where improvement in the child's situations might be focused. Sensitivity analysis was implemented on the four children outlined in the previous section. However, sensitivity analysis can be conducted on any or all of the scores generated from the value model. The preliminary global or local weights can be adjusted depending on the area, change in situation, or expertise of a different decision maker with a proper facilitation of the weighting. For purposes of this research, sensitivity analysis was conducted on these four children to demonstrate how changing the weighting scheme for different evaluation measures can change the children's overall scores.

To conduct sensitivity analysis, the global weights for the first tier values are adjusted one at a time. While one weight is being adjusted from 0 to 1, the other three weights change proportionally. This method of sensitivity analysis allows the user to further examine the trouble areas for the child. Sensitivity analysis computed in this fashion also allows for other experts opinions' on how each evaluation measure should be weighted to be considered.

The first evaluation measure to perform sensitivity analysis on was Lifestyle/Status. The DM determined, by the use of swing weighting, that .3125 was an appropriate weight for this measure. Figure 14 shows that while changing this value from 0 to 1, and the other evaluation measures on this tier changed proportionally, each child's overall value or score changes as well.

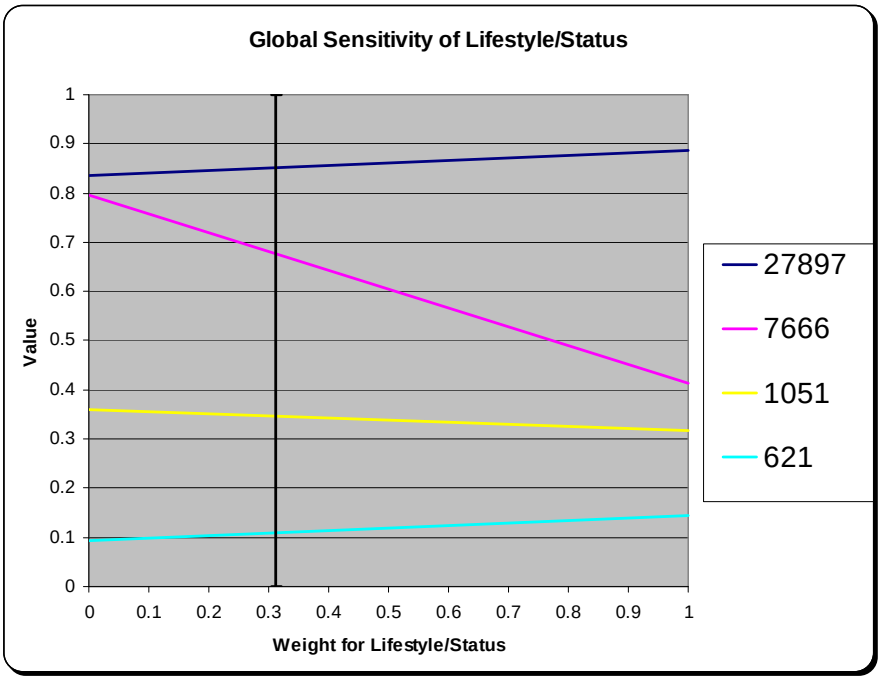


Figure 14. Sensitivity of Lifestyle/Status

As seen in Figure 14, changing the weighting scheme of Lifestyle/Status had little effect on three of the children. However, when Lifestyle/Status was deemed more

important, then Child 7666 experienced a dramatic decrease in likelihood of being "at risk" and joining a street gang suggesting a sensitivity to Lifestyle/Status. Child 7666 experienced this change due to the fact that he/she scores high in income, and little elsewhere, making the change in Lifestyle/Status weight influential. Child 27897 experienced little change due to the fact he/she scores high on all the other evaluation measures as well; that is, is "at risk" in all areas capture in the model.

The next evaluation measure that was used in sensitivity analysis was Acceptance. Similar to Lifestyle/Status, the DM determined the appropriate weight for Acceptance to be .3125. Figure 15 portrays the results from conducting sensitivity analysis on Acceptance.

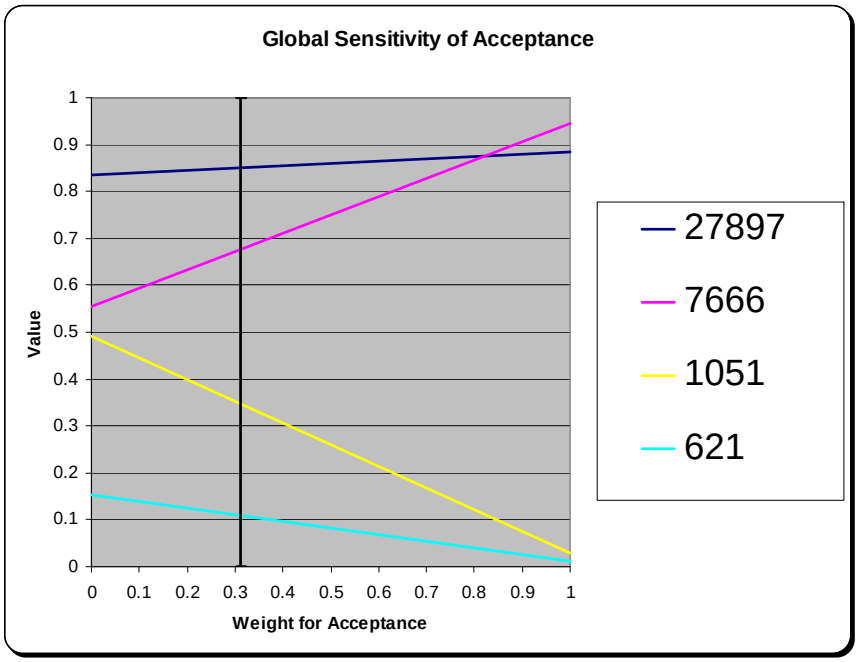


Figure 15. Sensitivity of Acceptance

Figure 15 shows that three of the four children experienced dramatic changes in overall value scores with the increase of weight on Acceptance. In fact, Child 7666 becomes more "at risk" than Child 27897 when the Acceptance weight is set at

approximately .80. This is mainly attributed to the fact that Child 7666 has family and friends in street gangs currently. Child 1051 and Child 621 achieve a score of almost zero when Acceptance is increase enough. This situation occurs since these two children do not have any friends or family members associated with street gangs and a high level of acceptance in their lives.

The next evaluation measure for which sensitivity analysis was conducted was Survival/Security. The DM determined the appropriate weight for Survival/Security to be .0625. Figure 16 displays the results from conducting sensitivity analysis on Survival/Security

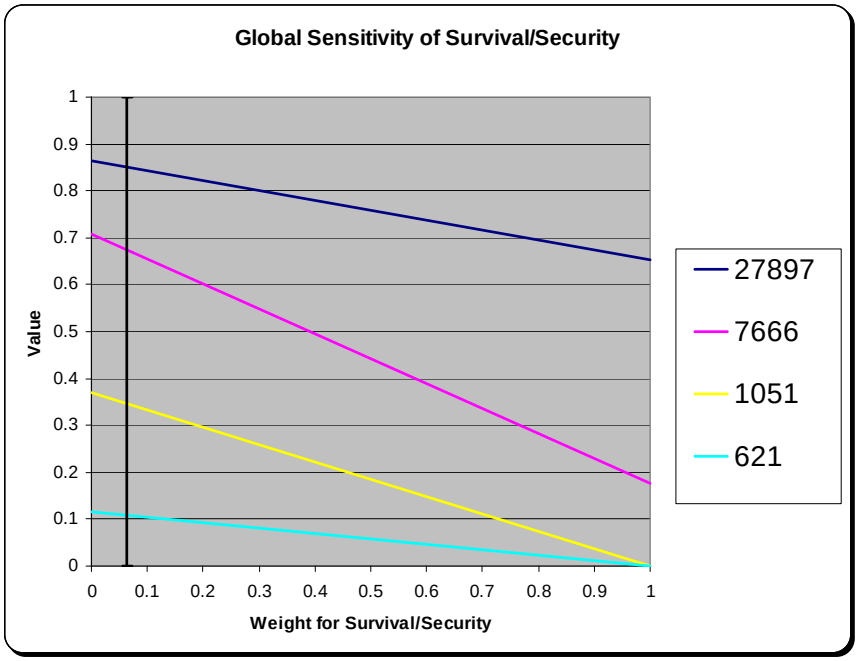


Figure 16. Sensitivity of Survival/Security

As seen in Figure 16, all four children were sensitive to an increase in the weight with regards to Survival/Security. Two of the children (1051 and 621) are not living in areas that pose a risk of gangs and gang-related violence.

The final sensitivity analysis was on the weighting of Family Stability. Similar to Lifestyle/Status and Acceptance, the DM weighted Family Stability as .3125. Figure 17 shows the change in scores for the four different children while fluctuating the Family Stability weight.

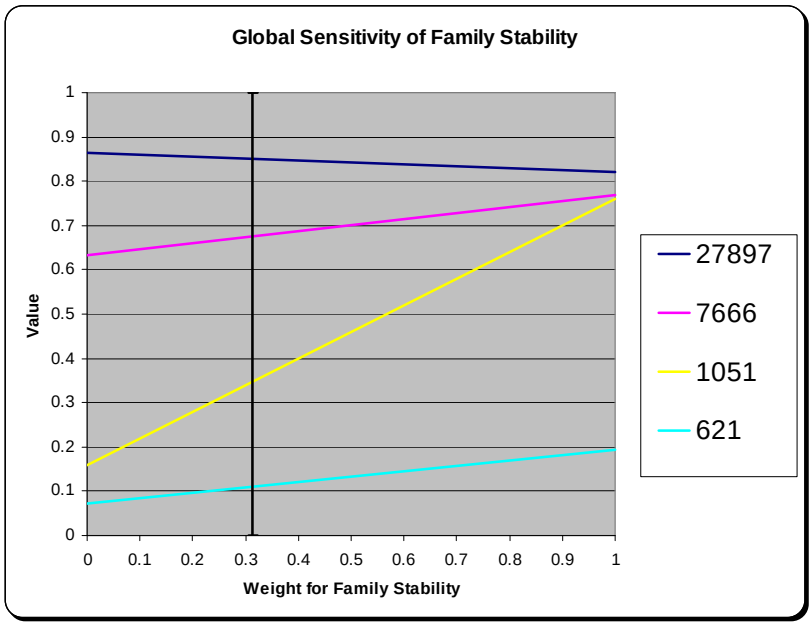


Figure 17. Sensitivity of Family Stability

Figure 17 suggests that three of the four children were likely to become scored as more "at risk" with an increase in the Family Stability weight. These three children lost one or two parents within the previous year and deviated from the nuclear family type. Child 1051 was affected the most by the change in weighting scheme while Child 27897 experienced very little change based on the weight of Family Stability. If it was felt that the weight should be increased, these youths would be considered by the model to be more "at risk."

The sensitivity analysis has provided some insight into children to be considered "at risk." Sensitivity analysis on all 83,004 children would become difficult, but

examining children on the cutoff boundaries might be deemed important. Performing sensitivity analysis on the boundaries allows the user to determine what events might help cause the child to change from not being "at risk" to being highly "at risk." This prior knowledge can allow officials or professionals to keep an eye on the child during particular events.

Gang Prevention Programs Illustration

The following section demonstrates the use of operations research allocation models in selecting programs. Once "at risk" youths have been identified and scored with the value model, preventative measures should be considered. The following notional illustration is provided to demonstrate the potential of using other operations research techniques. The value model results are used only indirectly, aiding in creating bounds for some of the constraints.

To better assist in gang reduction and reducing the number of "at risk" children for Montgomery County, different gang prevention programs can be placed in different cities. For this demonstration, 6 notional gang prevention programs were developed; each program had a specific mission, associated hypothetical cost, and some type of notional benefit to illustrate how other operations research techniques might be utilized. The benefit of each program was a hypothetical percent reduction in the number of "at risk" children in the city the programs were implemented. It is important to note that three of the programs (DARE, GREAT, and PAL) are existing programs in gang prevention within the United States but their costs and benefits are notional. The other three example programs are completely notional examples.

The first program is Drug Abuse Resistance Education (better known as D.A.R.E.). The purpose of D.A.R.E. is to "provide children with the skills they need to avoid involvement in drugs, gangs, and violence" (DARE, 2008). D.A.R.E. has an established curriculum that is taught by either teachers or police officers and revolves around the negative use of drugs and alcohol. This program also hosts celebrity cartoon figures such as McGruff to aid in reaching out to the children in a positive nature and teach them the dangers of drugs. Handouts such as shirts, buttons, hats, and many other items displaying the D.A.R.E. logo and messages are also given to the children free of charge.

Based on the statistics published by D.A.R.E., an estimated 1.3 billion dollars was spent on nearly 36 million children in the year 2001 (DARE, 2008). No more specific details were found in the literature review. For this thesis, the notional cost to implement a D.A.R.E. program in a community was estimated at $36 per child. The benefit of the D.A.R.E. program in each city was arbitrarily set as a one percent reduction of "at risk" children in the community. This number is notional and does not reflect the exact benefit of the D.A.R.E. program. It is important to remember this model is for "at risk" children likely to join street gangs; the drug aspect is only one factor in the equation.

G.R.E.A.T. is the Gang Resistance Education and Training program. It is a "school-based, law enforcement officer-instructed classroom curriculum" (BJA, 2007). Its overall objective is to be an "immunization against delinquency, youth violence, and gang membership" (BJA). G.R.E.A.T. provides four different components: Middle school curriculum, elementary school curriculum, a summer program, and families' training. The curriculums are designed to promote positive behavior among the children,

expose the children to the dangers and negativity of gangs, and establish positive relationships with police and other officials (BJA). Families' training is designed to work on parent/guardian and child relationships and educate the families about indicators of negative behavior.

Based on the home website for G.R.E.A.T. and the Bureau of Justice Grant Department (2008), to establish this program in a community, the notional flat rate cost would be $150,000. This cost was to be treated as notional because it may be different than actual amounts. Based on average success rates published by G.R.E.A.T., the benefit of this program in each city was estimated to be 5.2 percent reduction of "at risk" children likely to join a street gang. While the same percentage was used for all cities in the illustration, it could vary by community.

The National Association of Police Athletics/Activities League (PAL) is an organization that "utilizes educational, athletic, and recreational activities to create trust and understanding between police officers and youth" (PAL, 2006). The police leagues give children the opportunity to be involved with sports and other extracurricular activities; this is an important program to keep the children involved with the "right" crowd of people as well.

Costs for the PAL program include equipment and other necessary items to run a successful league. The program can include any sport and the individuals involved would need to be considered volunteers to keep the cost down. An estimated cost of PAL was $50,000 for the city of Dayton. The cost for the other cities in Montgomery County was estimated to be proportional to the number of children living that city compared to the number living in Dayton. For example, if Kettering had half the number of children

as Dayton, it cost Kettering $25,000 to implement PAL. The overall benefit of PAL was assumed to be the same for each city and the reduction of "at risk" children was three percent. Again, these figures are notional and do not reflect actual costs and benefits.

A hypothetical gang prevention program included increased police force (PF) in each city. This increased force included adding a detective or detectives experienced in the area of gangs to the department, increasing time spent on street gangs rather than other areas, and/or devoting resources to gang research. Many gangs have moved to the Internet and attention needs to be drawn to popular gang blog sites and chat rooms to stop the recruitment of new gang members (Bennish, S., Wynn, K. & Fox, R.J, 2008).

A recent street gang study was conducted on the city of Dayton (Bennish *et al*., 2008). A grant of $99,000 was given to the police department to focus their efforts on reducing the impact of gangs in the area. This number was used to estimate the notional cost of PF in the city of Dayton. As previously suggested, the other cities costs were estimated to be proportional to the number of children in each city. The benefit of PF was a notionally estimated 6.2 percent reduction in "at risk" children. This number was higher due to the DM's explanation of gang presence carrying greater weight in regards to a child being "at risk" to join a street gang.

A fifth hypothetical program in gang prevention was Child Outreach Services (COS). This program is designed to have professionals on hand to assist children in areas of abuse, peer pressure, loneliness, family situations, and many other common symptoms associated with troubled children. Both individual and group attention can be given by professionals at the child's discretion. This hypothetical program is supplemental to the available school psychologists or other professionals already integrated in the school

system. This program is also an anonymous participation program in hopes to attract more children to use its resources.

The cost for the notional COS was arbitrarily set at $50,000 per 5,000 children. This amount was assumed to be sufficient in hiring either the necessary number or quality of professionals to assist the children with any problems. The success or benefit associated with COS was a notional four percent reduction in the number of "at risk" children in each city COS was established.

The last hypothetical program used in this thesis was an After School Outreach Program (ASOP). The purpose of this notional program is to provide latchkey children or children who need a safe environment with a place to go after school. This program is an alternative to sports or other school related activities in that it is an establishment for the child to complete homework, hang out with non-gang friends, or meet other children. Counselors would be on hand to keep the children involved until the parents are home or pick them up. This notional program, if properly administered, offers children opportunity to avoid being alone and avoid turning to the streets for companionship.

The cost of this hypothetical program was arbitrarily set to be $50,000 per 500 children. This cost included employing the counselors to ensure that there is a facilitator or adult supervision on the premises. This number could easily change based on the demand of this program (more children involved could demand more counselors). It is doubtful that all 500 children would attend ASOP; therefore, this estimated figure provided an upper bound. The benefit of ASOP was arbitrarily hypothesized as an 8 percent reduction of children "at risk" due to adult supervision, involvement in extracurricular activities, and meeting non-gang affiliated people.

Table 11. Notional Gang Prevention Programs and Associated Costs and Benefits

City	DARE		GREAT		PF	
	Cost	Benefit	Cost	Benefit	Cost	Benefit
Brookville	33696	1%	150000	5.2%	3094	6.2%
Carlisle	36216	1%	150000	5.2%	3326	6.2%
Centerville	131976	1%	150000	5.2%	12120	6.2%
Clayton	102132	1%	150000	5.2%	9379	6.2%
Dayton	1078056	1%	150000	5.2%	99000	6.2%
Englewood	78084	1%	150000	5.2%	7171	6.2%
Huber Heights	276048	1%	150000	5.2%	25350	6.2%
Kettering	344736	1%	150000	5.2%	31658	6.2%
Miamisburg	131760	1%	150000	5.2%	12100	6.2%
Moraine	44100	1%	150000	5.2%	4050	6.2%
Oakwood	72792	1%	150000	5.2%	6685	6.2%
Riverside	149688	1%	150000	5.2%	13746	6.2%
Springboro	99360	1%	150000	5.2%	9124	6.2%
Trotwood	197964	1%	150000	5.2%	18179	6.2%
Union	42588	1%	150000	5.2%	3911	6.2%
Vandalia	92412	1%	150000	5.2%	8486	6.2%
West Carrollton	76536	1%	150000	5.2%	7028	6.2%

City	PAL		COS		ASOP	
	Cost	Benefit	Cost	Benefit	Cost	Benefit
Brookville	1563	3%	9360	4%	93600	8%
Carlisle	1680	3%	10060	4%	100600	8%
Centerville	6121	3%	36660	4%	366600	8%
Clayton	4737	3%	28370	4%	283700	8%
Dayton	50000	3%	299460	4%	2994600	8%
Englewood	3622	3%	21690	4%	216900	8%
Huber Heights	12803	3%	76680	4%	766800	8%
Kettering	15989	3%	95760	4%	957600	8%
Miamisburg	6111	3%	36600	4%	366000	8%
Moraine	2045	3%	12250	4%	122500	8%
Oakwood	3376	3%	20220	4%	202200	8%
Riverside	6942	3%	41580	4%	415800	8%
Springboro	4608	3%	27600	4%	276000	8%
Trotwood	9182	3%	54990	4%	549900	8%
Union	1975	3%	11830	4%	118300	8%
Vandalia	4286	3%	25670	4%	256700	8%
West Carrollton	3550	3%	21260	4%	212600	8%

A summary of the 6 different notional example programs is given in Table 11. Once again, the costs and benefits of these notional examples are notional numbers. Exact costs and benefits could be implemented if the information was readily available. Each city can have all 6 programs established (depending on the budget). For this

illustrative example, it is assumed that all 6 programs have an independent effect of the population. In actual application, it would be important to assess the potentially multiplicative effects of multiple programs. In this study, establishing independent programs simply means that one program does not affect the outcome of another. While this is likely not the case in a real world setting, these notional examples are established with the assumption of no interaction between the programs. The total number of programs that could be established in Montgomery County is 102 (17 cities times 6 programs).

Knapsack Analysis

It is assumed in the notional analysis that the goal of establishing these 6 gang prevention programs in the 17 different cities of Montgomery County is to maximize the amount of reduction in the number of "at risk" children while limiting the total cost. Such a problem can be expressed as a knapsack problem.

In this illustrative example, the objective function was to maximize the benefit while keeping costs below a specified budget. The only other requirement of the integer knapsack problem is that each variable is assigned either a 0 or 1 which represents that the city funds a particular program or it does not.

Table 12 lists the seventeen cities considered for this notional analysis; cities are denoted as i=1,..,17. The six programs were also considered for this problem and denoted as j=1,…,6, as shown in Table 13. A particular budget (B) was also given in the constraint as a maximum amount of money that could be spent for the entire county. Finally, each variable (x_{ij}) must be either a 0 or 1. For the first knapsack problem, the

benefit was the percent reduction multiplied by the city's entire child population (e.g. 4000*10% = 400 = benefit).

Table 12. City for each i

City	i
Brookville	1
Carlisle	2
Centerville	3
Clayton	4
Dayton	5
Englewood	6
Huber Heights	7
Kettering	8
Miamisburg	9
Moraine	10
Oakwood	11
Riverside	12
Springboro	13
Trotwood	14
Union	15
Vandalia	16
West Carrollton	17

Table 13. Program for each j

Program	j
DARE	1
GREAT	2
PF	3
PAL	4
COS	5
ASOP	6

Maximize

$$9x_{11}+10x_{21}+37x_{31}+28x_{41}+299x_{51}+22x_{61}+77x_{71}+96x_{81}+37x_{91}+$$
$$12x_{101}+20x_{111}+42x_{121}+28x_{131}+55x_{141}+12x_{151}+26x_{161}+21x_{171}+$$
$$49x_{12}+52x_{22}+191x_{32}+148x_{42}+1557x_{52}+113x_{62}+399x_{72}+498x_{82}+190x_{92}+$$
$$64x_{102}+105x_{112}+216x_{122}+144x_{132}+286x_{142}+62x_{152}+133x_{162}+111x_{172}+$$
$$58x_{13}+62x_{23}+227x_{33}+176x_{43}+1857x_{53}+134x_{63}+475x_{73}+594x_{83}+227x_{93}+$$
$$76x_{103}+125x_{113}+258x_{123}+171x_{133}+341x_{143}+73x_{153}+159x_{163}+132x_{173}+$$
$$28x_{14}+30x_{24}+110x_{34}+85x_{44}+898x_{54}+65x_{64}+230x_{74}+287x_{84}+110x_{94}+$$
$$37x_{104}+61x_{114}+125x_{124}+83x_{134}+165x_{144}+36x_{154}+77x_{164}+64x_{174}+$$
$$37x_{15}+40x_{25}+147x_{35}+113x_{45}+1198x_{55}+87x_{65}+307x_{75}+383x_{85}+146x_{95}+$$
$$49x_{105}+81x_{115}+166x_{125}+110x_{135}+220x_{145}+47x_{155}+103x_{165}+85x_{175}+$$
$$75x_{16}+80x_{26}+293x_{36}+227x_{46}+2396x_{56}+174x_{66}+613x_{76}+766x_{86}+293x_{96}+$$
$$98x_{106}+162x_{116}+333x_{126}+221x_{136}+440x_{146}+95x_{156}+205x_{166}+170x_{176}$$

Subject to:

$$3396x_{11}+36216x_{21}+131976x_{31}+102132x_{41}+1078056x_{51}+78084x_{61}+276048x_{71}+$$
$$344763x_{81}+131760x_{91}+44100x_{101}+72792x_{111}+149688x_{121}+99360x_{131}+197964x_{141}+$$
$$42588x_{151}+92412x_{161}+76536x_{171}+150000(x_{12}+x_{22}+x_{32}+x_{42}+x_{52}+x_{62}+x_{72}+x_{82}+x_{92}+$$
$$x_{102}+x_{112}+x_{122}+x_{132}+x_{142}+x_{152}+x_{162}+x_{172})+3094x_{13}+3326x_{23}+12120x_{33}+9379x_{43}+$$
$$99000x_{53}+7171x_{63}+25350x_{73}+31658x_{83}+12100x_{93}+4050x_{103}+6685x_{113}+13746x_{123}+$$
$$9124x_{133}+18179x_{143}+3911x_{153}+8486x_{163}+7028x_{173}+1563x_{14}+1680x_{24}+6121x_{34}+$$
$$4737x_{44}+50000x_{54}+3622x_{64}+12803x_{74}+15989x_{84}+6111x_{94}+2045x_{104}+3376x_{114}+$$
$$6942x_{124}+4608x_{134}+9182x_{144}+1975x_{154}+4286x_{164}+3550x_{174}+9360x_{15}+10060x_{25}+$$
$$36660x_{35}+28370x_{45}+299460x_{55}+21690x_{65}+76680x_{75}+95760x_{85}+36600x_{95}+$$
$$12250x_{105}+20220x_{115}+41580x_{125}+27600x_{135}+54990x_{145}+11830x_{155}+25670x_{165}+$$
$$21260x_{175}+93600x_{16}+100600x_{26}+366600x_{36}+283700x_{46}+2994600x_{56}+216900x_{66}+$$
$$766800x_{76}+957600x_{86}+366000x_{96}+122500x_{106}+202200x_{116}+415800x_{126}+$$
$$276000x_{136}+549900x_{146}+118300x_{156}+256700x_{166}+212600x_{176}\le 7500000$$
$$x_{ij}=[0,1]\forall i,j$$

Equation 7. Knapsack Problem

Equation 7 shows the numerical model of the knapsack problem to be solved. The coefficients of the objective function represent the number of youths in city *i* that benefit from program *j* implemented in their city. These could be represented in

percentages, but the number of children moved below an "at risk" threshold from the program was deemed a more appropriate number to consider. It is assumed all youths benefit from the retrospective programs; however, the benefit number represents the number of "at risk" children moved below the threshold. The coefficients in the constraint represent the cost to establish program *j* in city *i*. The last constraint ensures that each variable is assigned either a 0 or 1 representing whether or not city *i* funds program *j*. Typically the knapsack is modeled in summation notation leading to the large equation seen in this problem.

Frontline Premium Solver in Microsoft Excel was used to solve this knapsack problem. Table 14 displays the allocation of resources for this problem. Along with the program placement, Table 15 shows how much money is spent by Montgomery County and how much per taxpayer the gang funding would cost. In addition, the estimated notional benefit is shown for the entire county. It is important to note that an estimated 83,004 children live in Montgomery County and the notional benefit is the number of children that have been deterred as a percentage reduction in likelihood from wanting to join a street gang who previously may have deemed a risk for joining a gang.

The results obtained from the knapsack problem, as shown in Table 14, display the optimal program placement in Montgomery County. It is important to note that none of the cities established the notional D.A.R.E. program. This could be due to the hypothetical high cost D.A.R.E. maintains while notionally addressing very little of the "at risk" population, compared to the other five programs. As seen in Table 14, each city adopts the policy to establish PF, PAL, and COS before any other programs. This is due to these programs costing the least while providing maximum benefit to the children.

Once these three programs were established, several of the cities adopted either G.R.E.A.T. or ASOP and sometimes both programs. Typically the cities that adopted both programs were fairly large (and thus had more children) and could provide a greater benefit by establishing the programs. The larger cities would adopt G.R.E.A.T. before it would take on ASOP due to the lower cost of G.R.E.A.T. Smaller cities would take the reverse direction since ASOP was the cheaper alternative.

Table 14. Notional Example Program Placement for Montgomery County

City	Established Programs	% Reduction	$ Spent in Each City
Brookville	PF PAL COS	13.2	$14,017
Carlisle	PF PAL COS ASOP	21.2	$115,665
Centerville	GREAT PF PAL COS	18.4	$204,901
Clayton	GREAT PF PAL COS ASOP	26.4	$476,186
Dayton	GREAT PF PAL COS ASOP	26.4	$3,593,060
Englewood	PF PAL COS ASOP	21.2	$249,382
Huber Heights	GREAT PF PAL COS ASOP	26.4	$1,031,633
Kettering	GREAT PF PAL COS	18.4	$293,407
Miamisburg	GREAT PF PAL COS	18.4	$204,811
Moraine	PF PAL COS	13.2	$18,345
Oakwood	PF PAL COS	13.2	$30,281
Riverside	GREAT PF PAL COS	18.4	$212,269
Springboro	GREAT PF PAL COS ASOP	26.4	$467,333
Trotwood	GREAT PF PAL COS	18.4	$232,351
Union	PF PAL COS ASOP	21.2	$136,016
Vandalia	GREAT PF PAL COS	18.4	$188,442
West Carrollton	PF PAL COS	13.2	$31,838

Table 15. Notional Cost and Benefit for Program Placement

Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
$7,499,937	$20.22	18524	22.32

If funding was not an issue for Montgomery County, the cost constraint could be removed from the optimization problem. This entailed placing each program in every city. Table 16 displays the results for the unconstrained optimization problem and the differences from cutting the budget nearly in half.

Table 16. Solution for No Constraints and Difference from Constrained

	Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
No Constraint	$15,081,581	$40.67	22743	27.41
County Budget	$7,499,937	$20.22	18524	22.32
Difference	$7,581,644	$20.45	4217	5.09

As seen in Table 16, establishing each program in every city provides an increased percentage of "at risk" children of 5.09 percent over the solution for the budgeted choice. However, it cost twice as much to reach only 5 percent more of the "at risk" population. Possible reasons for this might be that the cities do not possess many "at risk" children and establishing a program in this city causes cost to heavily outweigh the benefit. The notional constrained optimal solution did not establish any D.A.R.E. programs whereas the notional unconstrained solutions added them. This substantially increased the costs while only reaching a relatively few children in terms of street gangs. Again, it should be noted that these examples are notional and do not represent actual results.

Due to this program placement being for the entire county, professionals and those that are on city council may wish to assume their community is supported. There are several ways to approach this issue. The first method was to add a constraint that required each city receive at least one program, as follows:

$$x_{i1} + x_{i2} + x_{i3} + x_{i4} + x_{i5} + x_{i6} \geq 1 \quad \forall i \tag{8}$$

This constraint is designed to have at least one program (any program) in each city *i*. Each city can score a 1 through 6 based on this constraint.

By inspection of Table 14 and after resolving the optimization problem with this additional constraint, the same answers were achieved as seen in Table 14 and Table 15.

Each of the cities has a gang prevention mission under the proposed plan. The next possible set of constraints is to spend tax funds in the city where they are generated (municipal rather than county funding). For instance, money received in Dayton is only used to establish programs in Dayton. To determine local funding, a notional budget was set as a maximum of twenty dollars for each adult in each city. The new constraints for this problem are shown in Equation 9.

Subject to:

$$33696x_{11} + 150000x_{12} + 3094x_{13} + 1563x_{14} + 9360x_{15} + 93600x_{16} \leq 57060$$
$$36216x_{21} + 150000x_{22} + 3326x_{23} + 1680x_{24} + 10060x_{25} + 100600x_{26} \leq 82300$$
$$131976x_{31} + 150000x_{32} + 12120x_{33} + 6121x_{34} + 36660x_{35} + 366600x_{36} \leq 387160$$
$$102132x_{41} + 150000x_{42} + 9379x_{43} + 4737x_{44} + 28370x_{45} + 283700x_{46} \leq 210200$$
$$1078056x_{51} + 150000x_{52} + 99000x_{53} + 50000x_{54} + 299460x_{55} + 2994600x_{56} \leq 2724660$$
$$78084x_{61} + 150000x_{62} + 7171x_{63} + 3622x_{64} + 21690x_{65} + 216900x_{66} \leq 201320$$
$$276048x_{71} + 150000x_{72} + 25350x_{73} + 12803x_{74} + 76680x_{75} + 766800x_{76} \leq 610880$$
$$344736x_{81} + 150000x_{82} + 31658x_{83} + 15989x_{84} + 95760x_{85} + 957600x_{86} \leq 958520$$
$$131760x_{91} + 150000x_{92} + 12100x_{93} + 6111x_{94} + 36600x_{95} + 366000x_{96} \leq 316580$$
$$44100x_{101} + 150000x_{102} + 4050x_{103} + 2045x_{104} + 12250x_{105} + 122500x_{106} \leq 113440$$
$$72792x_{111} + 150000x_{112} + 6685x_{113} + 3376x_{114} + 20220x_{115} + 202200x_{116} \leq 143860$$
$$149688x_{121} + 150000x_{122} + 13746x_{123} + 6942x_{124} + 41580x_{125} + 415800x_{126} \leq 387740$$
$$99360x_{131} + 150000x_{132} + 9124x_{133} + 4608x_{134} + 27600x_{135} + 276000x_{136} \leq 192400$$
$$197964x_{141} + 150000x_{142} + 18179x_{143} + 9182x_{144} + 54990x_{145} + 549900x_{146} \leq 438420$$
$$42588x_{151} + 150000x_{152} + 3911x_{153} + 1975x_{154} + 11830x_{155} + 118300x_{156} \leq 87820$$
$$92412x_{161} + 150000x_{162} + 8486x_{163} + 4286x_{164} + 25670x_{165} + 256700x_{166} \leq 240720$$
$$76536x_{171} + 150000x_{172} + 7028x_{173} + 3550x_{174} + 21260x_{175} + 212600x_{176} \leq 233840$$

$$x_{i1} + x_{i2} + x_{i3} + x_{i4} + x_{i5} + x_{i6} \geq 1 \quad \forall i$$
$$x_{ij} = [0,1] \forall i, j$$

Equation 9.

Table 17 displays the allocation for the different gang prevention programs in each of the 17 cities subject to hypothetical local budgets. As seen in Table 17, no city

has enough funding to establish all six example programs in their city. This is due to the high cost to establish ASOP in a city. As seen in the previous problem, each city establishes PF, PAL, and COS before any other program. The next choice in program selection depended on the city's remaining budget. G.R.E.A.T. took precedence over D.A.R.E. in the order of selection. If a city did not have enough money to fund G.R.E.A.T., that particular city funded D.A.R.E. If the city had sufficient funds to adopt both programs, the city would establish both programs. As seen in Table 17, the cities that possessed five programs were larger cities with a greater adult population. ASOP proved to be too expensive given the budget constraints when adopting any of the other five programs. Officials may be satisfied with the results of this program placement in that each city implements at least three programs.

Table 17. Program Placement for Problem Three (Notional Example)

City	Established Programs					% Reduction	$ Per Taxpayer
Brookville	DARE		PF	PAL	COS	14.2	$9.02
Carlisle	DARE		PF	PAL	COS	14.2	$10.01
Centerville	DARE	GREAT	PF	PAL	COS	19.4	$14.63
Clayton		GREAT	PF	PAL	COS	18.4	$14.42
Dayton	DARE	GREAT	PF	PAL	COS	19.4	$10.09
Englewood		GREAT	PF	PAL	COS	18.4	$14.91
Huber Heights	DARE	GREAT	PF	PAL	COS	19.4	$14.15
Kettering	DARE	GREAT	PF	PAL	COS	19.4	$11.10
Miamisburg		GREAT	PF	PAL	COS	18.4	$10.51
Moraine	DARE		PF	PAL	COS	14.2	$9.05
Oakwood	DARE		PF	PAL	COS	14.2	$11.19
Riverside	DARE	GREAT	PF	PAL	COS	19.4	$15.37
Springboro		GREAT	PF	PAL	COS	18.4	$15.45
Trotwood	DARE	GREAT	PF	PAL	COS	19.4	$15.69
Union	DARE		PF	PAL	COS	14.2	$10.82
Vandalia		GREAT	PF	PAL	COS	18.4	$12.90
West Carrollton		GREAT	PF	PAL	COS	18.4	$13.16

Table 18 shows the total money spent by the county, average dollars spent per adult, and the total benefit or percent reduction in "at risk" children. As seen by these

results, the D.A.R.E. program is established in over half the cities, the total money spent has decreased, and the reduction percentage decreased as well. Table 19 compares the three problems completed to this point.

Table 18. Cost and Benefit of Program Placement (Notional Example)

Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
$5,450,897	$14.70	15610	18.81

Table 19. Summary of Three Solved Notional Problems

	Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
No Constraint	$15,081,581	$40.67	22743	27.41
County Budget	$7,499,937	$20.22	18524	22.32
Each City Budgets	$5,450,897	$14.70	15610	18.81

The three scenarios discussed summarized in Table 19 all have pros and cons associated with them. The most effective scenario for reduction of "at risk" youth would be to have no budget limit, but this solution is highly unlikely to be selected due to the high costs of implementing all the programs in each city. The county budget and city budget problems provide a compromise to the funding situation. If officials and citizens in Montgomery County did not prefer one over the other, the city budget constraint problem should be implemented to have the greatest effect in reducing the number of "at risk" children while maintaining a low yearly tax cost.

The previous three optimization problems all fell under the notion that *all* of the children of Montgomery County were somewhat "at risk." This assumes that every community has the same level of threat. There was no indication in terms of how many children were still highly "at risk" to join a street gang even after the reduction. To compensate for this, the benefits are adjusted to only consider those individuals who scored .500 or higher on the value model. The score of .500 was an arbitrary selection; a threshold could be applied at any level. To account for this change, the notional benefit

(percentage) of each of the programs was multiplied only against the number of children scoring above .500 in the value model. All other numbers remained the same. The knapsack problem was constructed in a similar fashion with only the objective function changing values, as seen in Equation 10.

Maximize

$$0x_{11} + 0x_{21} + 2x_{31} + 2x_{41} + 36x_{51} + 2x_{61} + 6x_{71} + 6x_{81} + 2x_{91} +$$
$$1x_{101} + 1x_{111} + 3x_{121} + 1x_{131} + 5x_{141} + 1x_{151} + 2x_{161} + 2x_{171} +$$
$$1x_{12} + 1x_{22} + 11x_{32} + 9x_{42} + 187x_{52} + 8x_{62} + 29x_{72} + 33x_{82} + 13x_{92} +$$
$$5x_{102} + 6x_{112} + 15x_{122} + 8x_{132} + 24x_{142} + 4x_{152} + 10x_{162} + 8x_{172} +$$
$$1x_{13} + 2x_{23} + 13x_{33} + 11x_{43} + 223x_{53} + 10x_{63} + 34x_{73} + 40x_{83} + 15x_{93} +$$
$$6x_{103} + 7x_{113} + 18x_{123} + 9x_{133} + 29x_{143} + 4x_{153} + 11x_{163} + 10x_{173} +$$
$$1x_{14} + 1x_{24} + 7x_{34} + 5x_{44} + 108x_{54} + 5x_{64} + 17x_{74} + 19x_{84} + 7x_{94} +$$
$$3x_{104} + 3x_{114} + 9x_{124} + 4x_{134} + 14x_{144} + 2x_{154} + 5x_{164} + 5x_{174} +$$
$$1x_{15} + 1x_{25} + 9x_{35} + 7x_{45} + 144x_{55} + 6x_{65} + 22x_{75} + 26x_{85} + 10x_{95} +$$
$$4x_{105} + 5x_{115} + 12x_{125} + 6x_{135} + 19x_{145} + 3x_{155} + 7x_{165} + 6x_{175} +$$
$$2x_{16} + 2x_{26} + 17x_{36} + 14x_{46} + 288x_{56} + 12x_{66} + 44x_{76} + 51x_{86} + 19x_{96} +$$
$$8x_{106} + 9x_{116} + 24x_{126} + 12x_{136} + 38x_{146} + 6x_{156} + 15x_{166} + 13x_{176}$$

Equation 10.

With a threshold value of .500, the total number of synthetic children that were considered highly "at risk" was 7170 for Montgomery County. The unconstrained knapsack problem was first considered where funds were not an issue in reducing the number of "at risk" children. Each of the six gang prevention programs were placed in every city to obtain maximum benefit. Table 20 summarizes the total costs and benefits of running an unconstrained knapsack problem.

Table 20. Cost and Benefit of Program Placement for Unconstrained Modified Benefit Problem (Notional Example)

Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
$15,081,581	$40.67	1965	27.41

As seen in Table 20 compared to the results shown in Table 16, not unexpectedly, the answers are identical (with the exception of the number benefited). This output was expected since the costs have not changed and the benefits are in terms of percentage reduction. However, when the budget constraint of $7.5M was added for the entire county, different allocations were achieved than previously.

Table 21 displays the allocation for each program in the 17 different cities with county-wide funding. The assignment using the new benefit saw a difference from the assignment of Table 14. Essentially, five cities dropped the ASOP program and four different cities established the ASOP program. In this model, ASOP is dropped from the less "at risk" cities and established in the cities where more "at risk" children reside. The only other difference is that Springboro dropped the G.R.E.A.T. program to provide funding for the ASOP in a different city. Examining the assignment in Table 21 provides fairly accurate information on the need of establishing five programs in four of these cities which in the notional example are known to produce more "at risk" children on average in Montgomery County. Table 21 also compares the percentage reduction of "at risk" children in each of the cities.

Table 22 summarizes the results obtained from this new knapsack problem and calculates the difference between the constrained and unconstrained problems.

Table 21. Program Placement for At Risk" Children > .500 (Notional Example)

City	Established Programs					% Reduction	$ Spent in Each City
Brookville		PF	PAL	COS		13.2	$14,017
Carlisle		PF	PAL	COS		13.2	$15,065
Centerville	GREAT	PF	PAL	COS		18.4	$204,901
Clayton	GREAT	PF	PAL	COS		18.4	$192,486
Dayton	GREAT	PF	PAL	COS	ASOP	26.4	$3,593,060
Englewood		PF	PAL	COS		13.2	$32,482
Huber Heights	GREAT	PF	PAL	COS	ASOP	26.4	$1,031,633
Kettering	GREAT	PF	PAL	COS		18.4	$293,407
Miamisburg	GREAT	PF	PAL	COS		18.4	$204,811
Moraine		PF	PAL	COS	ASOP	21.2	$140,845
Oakwood		PF	PAL	COS		13.2	$30,281
Riverside	GREAT	PF	PAL	COS		18.4	$212,269
Springboro		PF	PAL	COS		13.2	$41,333
Trotwood	GREAT	PF	PAL	COS	ASOP	26.4	$782,251
Union		PF	PAL	COS		13.2	$17,716
Vandalia	GREAT	PF	PAL	COS	ASOP	26.4	$445,142
West Carrollton		PF	PAL	COS	ASOP	21.2	$244,438

Table 22. Solution to Budget Problem and Comparison to No Budget

	Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
No Constraint	$15,081,581	$40.67	1965	27.41
County Budget	$7,496,136	$20.21	1683	23.47
Difference	$7,585,445	$20.46	282	3.94

Compared to the objective function results in Table 16, these new results saw a one percent improvement in reducing the number of "at risk" children while only increasing the cost $0.01 per adult living in the county. By spending only $7.49M, the Montgomery County average was reduced 3.94 percent of "at risk" children that would have been accounted for with an additional $7.51M. Once again, this was due to not using the notional D.A.R.E. programs in any of the cities. The constraint that each city must have at least one program was also satisfied.

The last problem considered was restricting funding to local communities that generated them. The objective function remained the same and the constraints are the same constraints used in Equation 9 when looking at different city budgets (each adult

paying a maximum of twenty dollars yearly). Table 23 shows the program assignment for this restricted funding problem. The assignment is exactly the same as the assignment in the previous restricted funding problem, given in Table 17. The only difference is seen in Table 24 with the overall benefit. The percentage is higher since the model only deals with children scoring .500 or greater on the value model. Once again, the notional ASOP is too expensive to establish in any of the cities while maintaining a budget.

Table 23. Program Placement for Problem Six (Notional Example)

City	Established Programs					% Reduction	$ Per Taxpayer
Brookville	DARE		PF	PAL	COS	14.2	$9.02
Carlisle	DARE		PF	PAL	COS	14.2	$10.01
Centerville	DARE	GREAT	PF	PAL	COS	19.4	$14.63
Clayton		GREAT	PF	PAL	COS	18.4	$14.42
Dayton	DARE	GREAT	PF	PAL	COS	19.4	$10.09
Englewood		GREAT	PF	PAL	COS	18.4	$14.91
Huber Heights	DARE	GREAT	PF	PAL	COS	19.4	$14.15
Kettering	DARE	GREAT	PF	PAL	COS	19.4	$11.10
Miamisburg		GREAT	PF	PAL	COS	18.4	$10.51
Moraine	DARE		PF	PAL	COS	14.2	$9.05
Oakwood	DARE		PF	PAL	COS	14.2	$11.19
Riverside	DARE	GREAT	PF	PAL	COS	19.4	$15.37
Springboro		GREAT	PF	PAL	COS	18.4	$15.45
Trotwood	DARE	GREAT	PF	PAL	COS	19.4	$15.69
Union	DARE		PF	PAL	COS	14.2	$10.82
Vandalia		GREAT	PF	PAL	COS	18.4	$12.90
West Carrollton		GREAT	PF	PAL	COS	18.4	$13.16

Table 24 displays the optimal costs and benefits of this placement, and Table 25 summarizes the three types of situations explained with the new objective function. The difference in percent reduction in Table 19 was compared to the percent reduction shown in Table 25.

Table 24. Cost and Benefit of Program Placement for Problem Six (Notional Example)

Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
$5,450,897	$14.70	1363	19.01

Table 25. Summary of Costs and Benefits for New Objective Function (Notional Example)

	Total Dollars Spent	Avg. Cost Per Taxpayer Per Year	Benefit	% Reduction
No Constraint	$15,081,581	$40.67	1965	27.41
County Budget	$7,496,136	$20.21	1683	23.47
Each City Budgets	$5,450,897	$14.70	1363	19.01

These three problems are similar to the first three problems discussed in this chapter. The main difference associates with the percent reduction, which is due to only considering children scoring higher than .500 on the value model. Again, if funding is not an issue for the citizens of Montgomery County, all programs should be implemented in each city. However, as a compromise, the city budget should be used over the city budget due to the higher percentage reduction ratio associated with a lower cost.

Recommended Notional Model

The recommended model used in this notional illustration was determined by maximizing the percentage reduction in the number of seriously "at risk" youth with respect to minimizing the money spent in terms of overall reduction in Montgomery County. This scenario provided the largest "bang for buck" situation. To determine this value, sensitivity analysis was used for the city versus county budget. The notional model illustrated was to use the children scoring above .500 in the value model as the "at risk."

As seen in Figure 18, the county budget provides more percentage reduction overall in terms of money spent. This notional budget requires that each taxpayer in Montgomery County pays the same amount of tax dollars to fund gang prevention programs for the entire county. Using the city budget, the average dollars spent was used in the analysis, even though citizens of different cities paid different amounts (depending on the size of each city). Depending on the views of city officials and investigators,

either method will provide positive reduction, but for the county as a whole, the county budget provides the best notional percentage reduction of "at risk" children likely to join street gangs. Figure 18 also outlines the percentage reduction for each dollar amount spent by tax payers.

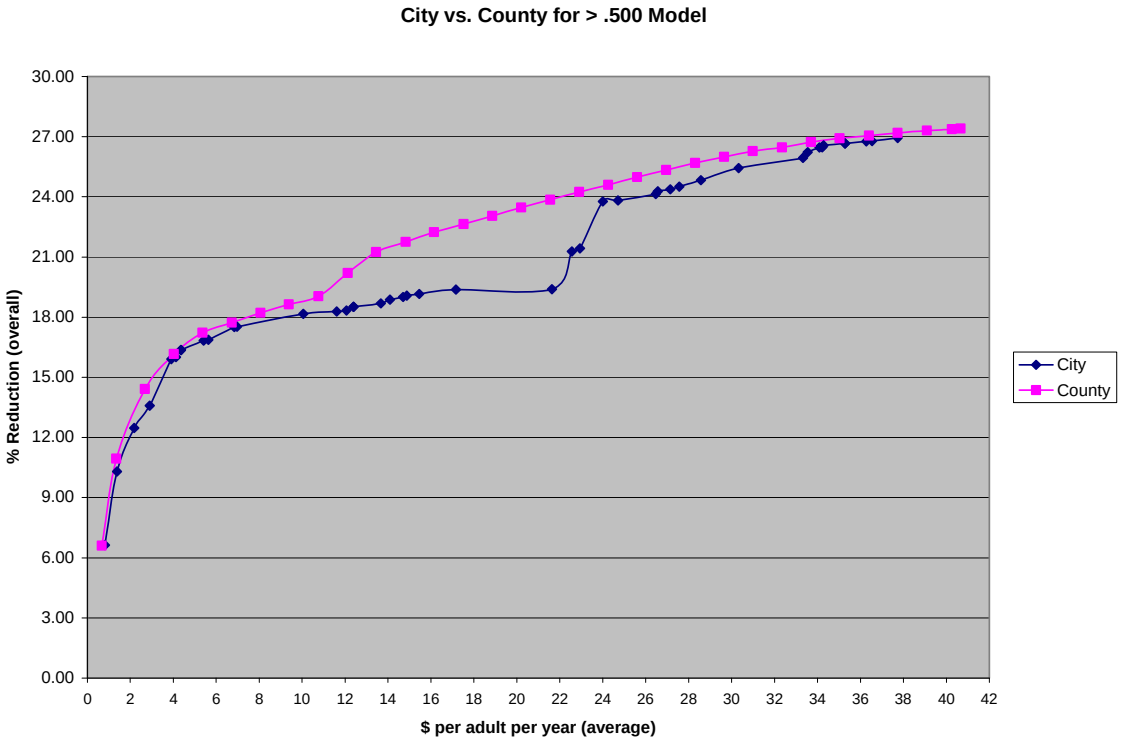


Figure 18. Sensitivity Analysis for City and County Budget Problem (Notional Example)

Figure 19 examines only the county budget since this was deemed a greater improvement while maintaining a low cost than the city budget. Two break points (lines) were inserted to demonstrate where the possible dollars spent should be considered. The first break point occurs at $6 and has the greatest marginal rate of increase from spending nothing on gang prevention programs. The second break point offers another large break point; it states that for an extra $8, nearly four percent more "at risk" youth would no

longer be "at risk." Once this limit is reached, more money is placed into the gang prevention programs, but smaller rates of percentage reduction are achieved.

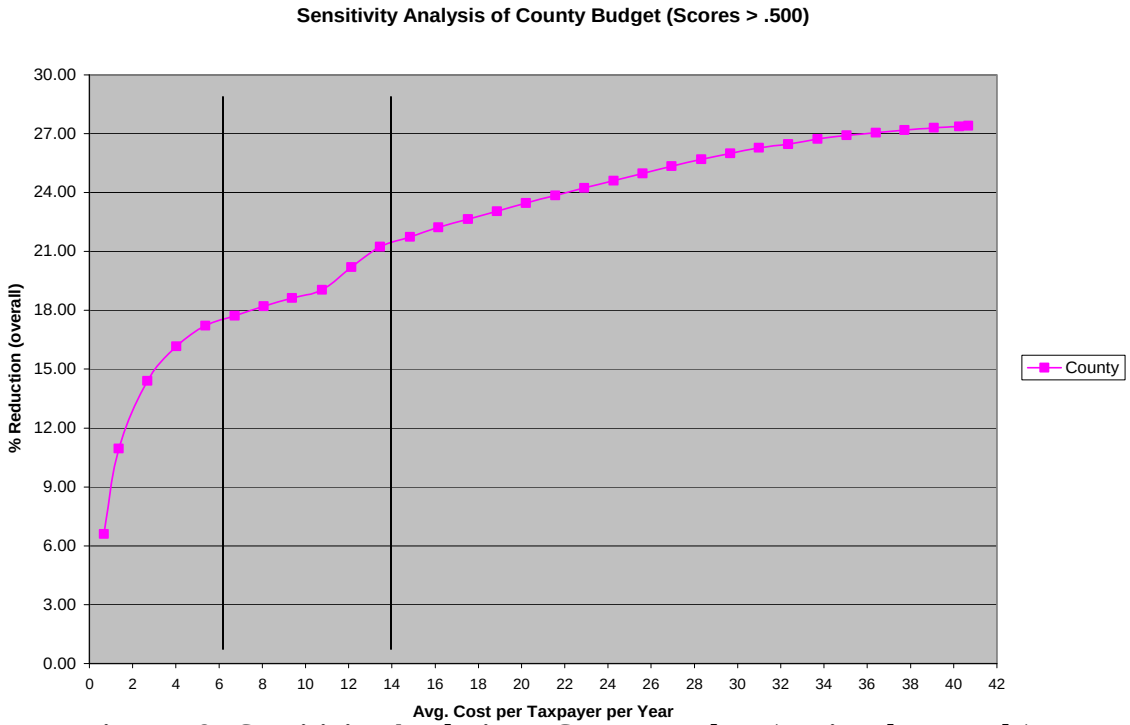


Figure 19. Sensitivity Analysis on County Budget (Notional Example)

Summary

It is important to note that the costs and benefits associated with the programs were based on a one year expenditure. Residual and longitudinal effects were not incorporated into this example. If information is available on the costs and benefits over a period of time, then these costs could be included in an optimization problem and be resolved. In addition, the benefit of each program was assumed to be the same for every city. Actual benefits may vary from city to city and this number could be adjusted to represent real-life benefit.

Finally, the illustrative example is just that; a notional illustration. The arbitrary costs and benefits should in no way be considered as the actual figures. Detailed

community studies are required to accurately estimate actual costs and benefits. These example scenarios are purely provided to illustrate the potential use of operations research techniques in the public sector problems and how ranking from the value model might be used in other analyses to aid community officials and planners.

Chapter 5 summarizes the Ishikawa diagram and value focused thinking approaches performed while studying “at risk” children likely to join street gangs. Similarities to terrorist groups and street gangs are briefly discussed in Chapter 5. Different areas of further research regarding street gangs and terrorist groups will also be presented in hopes to reduce their presence and ability to attract new members.

V. Conclusions and Recommendations

Summary

Fishbone (Ishikawa) diagrams were created to facilitate creating a value model in determining potentially "at risk" children likely to join street gangs. The model developed captures the decision maker, a current detective of Montgomery County in charge of gang prevention and crime, preferences providing the necessary values, measures, and weights. After creating the model, a notional data set representative of the children of Montgomery County was created. 83,004 representative synthetic children were developed with raw attributes that were scored and divided by city. The scores provided notional information on the individuals that posed the highest "risk" for joining a street gang and what cities possessed a higher percentage of "at risk" children compared to the other cities of Montgomery County.

Sensitivity analysis was conducted on four synthetic children selected from the model to demonstrate how changing the weights of the 1st tier values adjusted the children's scores. A more in-depth study into the sensitivity analysis of each child could be conducted but requires much time and effort.

Research Contributions

The Ishikawa diagram and value model created in this thesis can assist in the ongoing process of reducing the number of children joining street gangs in Montgomery County. The reduction of new street gang recruits may lead to a reduction in the number and impact of street gangs. The model provides tools to educate communities on the sources of "at risk" youths. In addition, the value model provides a mechanism to rank and screen "at risk" youths for further attention. This can help in focusing efforts and

resources. The notional operations research analysis can solidify reasons for tax dollars being spent on gang prevention in Montgomery County. Montgomery County is already on the initiative that "we're going to stop them [street gangs] from growing to being where we have a major gang problem out here [Montgomery County]" (Bennish *et.al*., 2008: A8).

This model can be adjusted to represent other cities or counties around the country. The approach used to develop the value model created for potentially "at risk" children likely to join a street gang may also be potentially useful in identifying youth "at risk" of joining terrorist groups around the world. Recruitment for a terrorist group is similar to a common street gang. Arguments can be made that children join terrorist groups due to a desire for a different life (Lifestyle/Status), friends and family members already involved in terrorist groups (Acceptance), terrorist groups being established in the area and is a way of life (Survival/Security), or the child may need the family structure that a terrorist group could provide (Family Stability). Similar applications can be made to help focus efforts reducing the number of "at risk" children likely to join a terrorist groups as done with street gangs. Programs could be developed based on the needs and costs in different areas affected by terrorist groups. Further research in this area is necessary to validate this claim and provide a working model to reduce the number of potentially "at risk" children likely to join a terrorist group.

A major assumption made in Chapter 4 is that the created data, gang prevention programs, costs, benefits, and optimal solutions were all notional. Despite the strong effort to represent Montgomery County, the models are still hypothetical and would need to be validated with actual data and information. However, insight can be gained from

learning why different programs should be placed in different cities and how much money would be required from tax payers.

Future Research

Application to other cities or counties throughout the state could be done using the value model created. Real data collection and implementation into the model would validate real world results and situations. In addition, existing and real world gang prevention programs could be researched and created to deem their effects (costs and benefit) in Montgomery County. Examining "at risk" cities rather than children could be another avenue of research taken to primarily decide which cities need more attention. Validation of the model from outside and national agencies can be conducted to evaluate the overall possible usage of the model. To aid in resource allocation within a community, a portfolio, or community aide model could be developed to compliment the individual focused model developed in this thesis.

Extensions to "at risk" children and terrorist groups could be performed using a similar model and approach. Researching the similarities of those children likely to join street gangs and terrorist groups could provide necessary knowledge in reducing the number of terrorists in the world. VFT analysis could quantifiably justify anti-terrorist movements being implemented in the nation and world today.

Conclusion

Overall, this research used decision analysis techniques to develop a value model to assist in identifying "at risk" youth. A notional analysis was also provided to show how operations research techniques might assist in public decision making. The funds needed to establish programs may be funded through different grants available from the

federal government and/or taxpayer dollars. To reduce the presence of gangs in the cities of Montgomery County could be an important issue to the citizens of these cities to provide a safer and more enjoyable environment for children to grow.

Appendix A: Value Model, Evaluation Measures, and SDVFs

The value model used in this thesis was created using Microsoft Excel. This model can be accessed on an Excel worksheet for further use. The SDVFs for each evaluation measures are included on the same worksheet as the value model. Finally, the synthetic data set used in the illustrative example was created using the uniform random distribution embedded in Excel. Worksheets were created for each city along with a worksheet of the summary statistics gathered from census data, Ohio reports, and other relevant surveys based on Montgomery County. The rest of this appendix provides a more detailed explanation of the evaluation measures and associated SDVFs used for the value model.

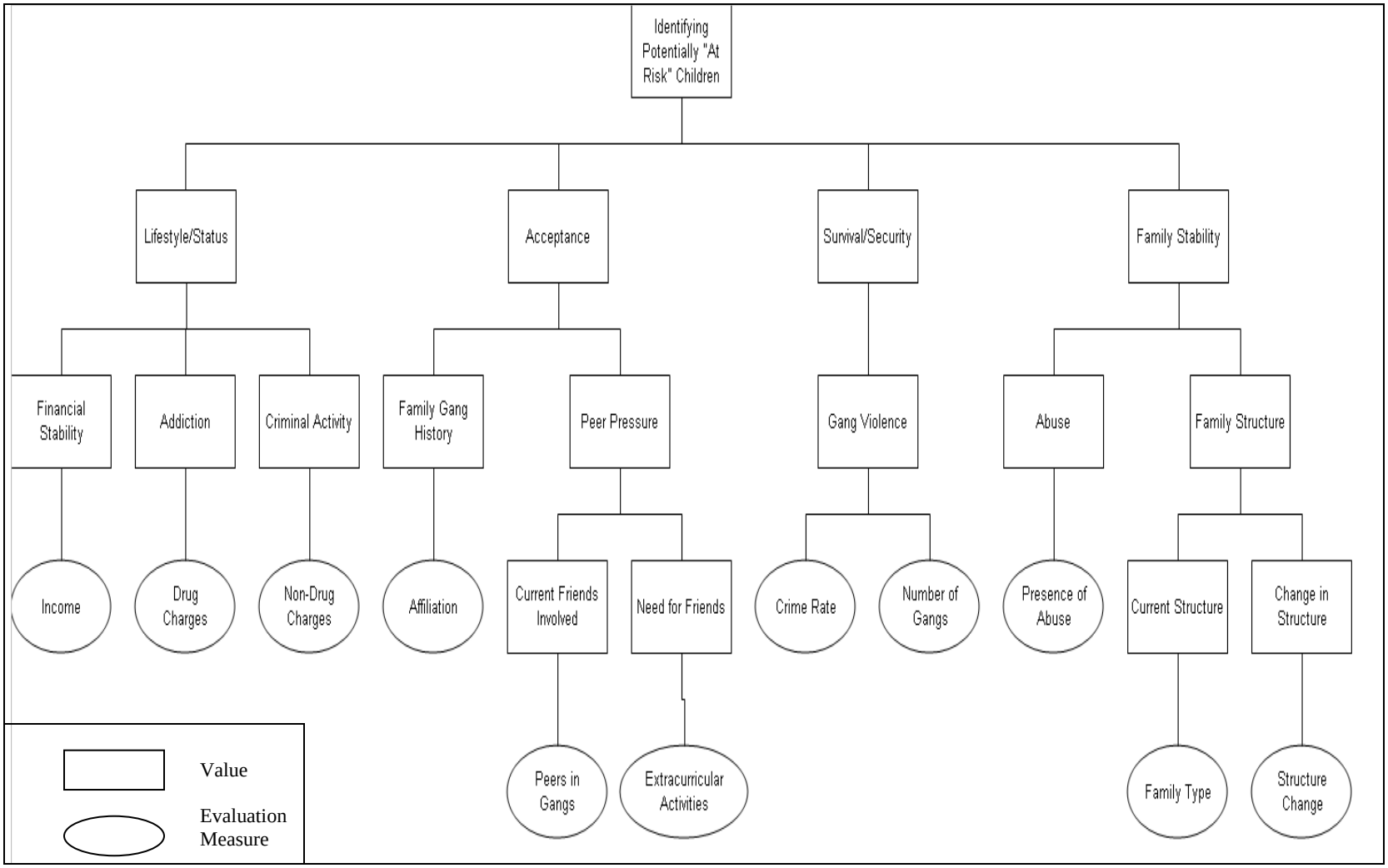


Figure 20. Value Model

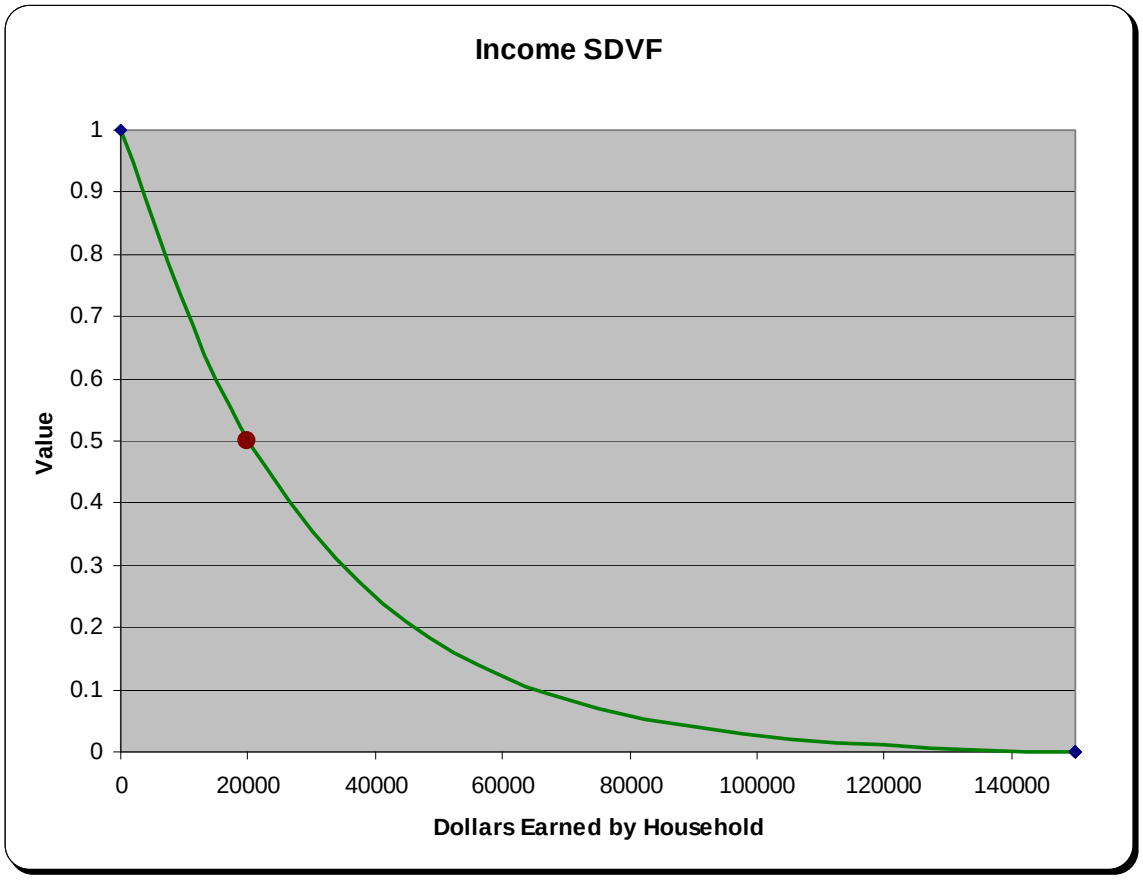


Figure 21. Income SDVF

Income is a measure of income earned by the child's family. Incomes are taken from the neighborhood to determine what level of income the child's family most likely represents. If actual household income can be determined, this measure can become a direct measure.

Income is measured using the exponential value function. The bounds are at $0 and $150,000. Any neighborhood scoring above $150,000 has a value of 0. The curve represents that "less is better" and has a midpoint at $20,000.

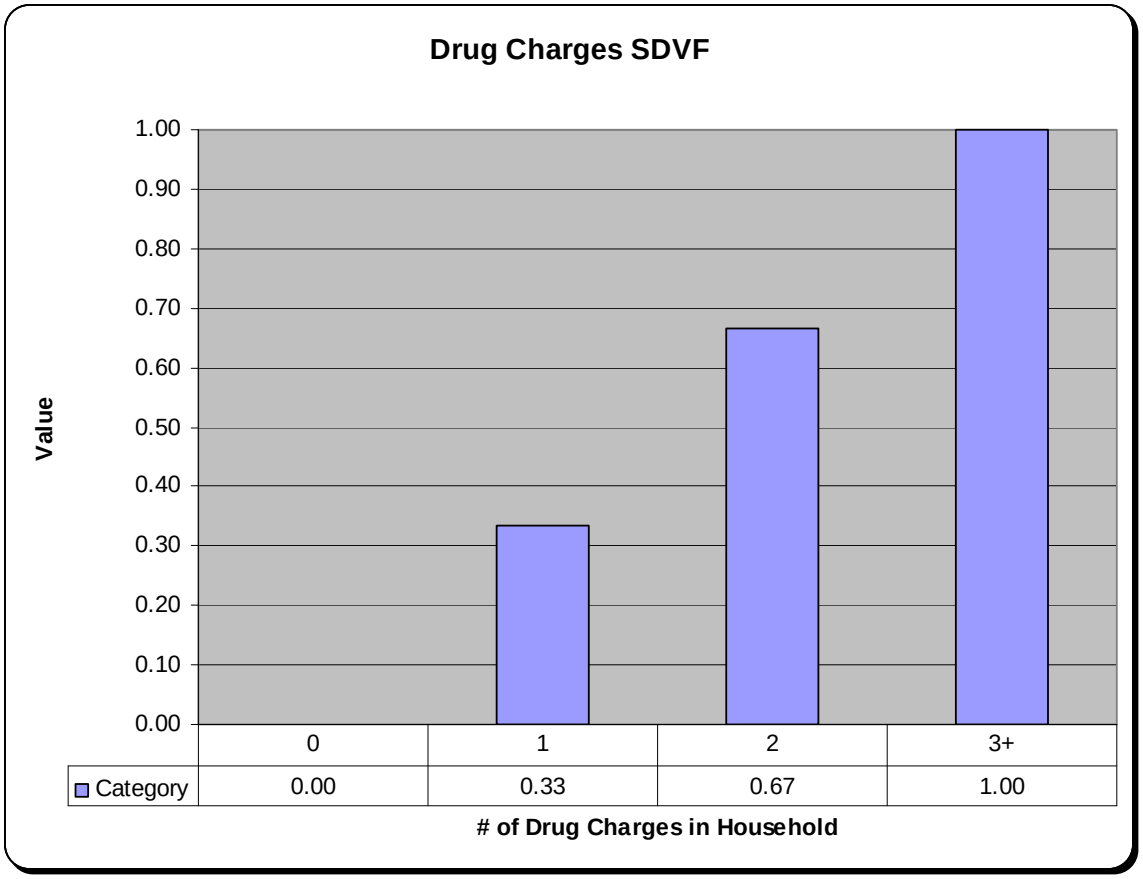


Figure 22. Drug Charges SDVF

Drug Charges measures the number of drug related charges the household has on record. It assumes the more drug charges a household incurs, the more likely the child is either a user or seller of drugs.

Drug Charges is represented as a linear function. It is important to note that only whole numbers are used in this SDVF. Therefore, the only numbers involved are 0, 1, 2, and 3. Any household that has 3 or more drug charges in the household receives a value of 1.

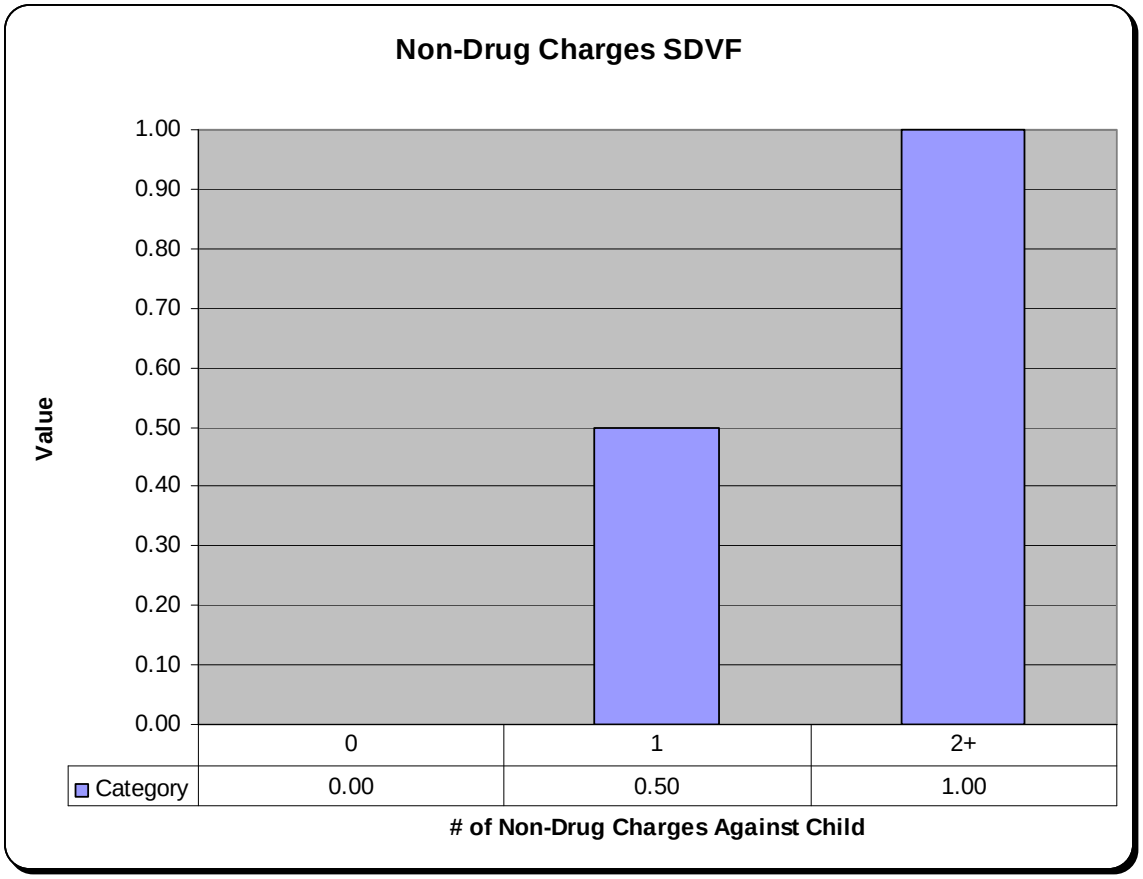


Figure 23. Non-Drug Charges SDVF

Non-Drug Charges measures the number of violent crimes with which a child has been charged. This measure approximates the relation between the number of violent crime charges with likelihood to be involved in future criminal activity.

Non-Drug Charges is represented as a linear function. It is important to note that only whole numbers are used in this SDVF. Therefore, the only numbers involved are 0, 1, and 2. Any youth that has 2 or more non-drug charges receives a value of 1.

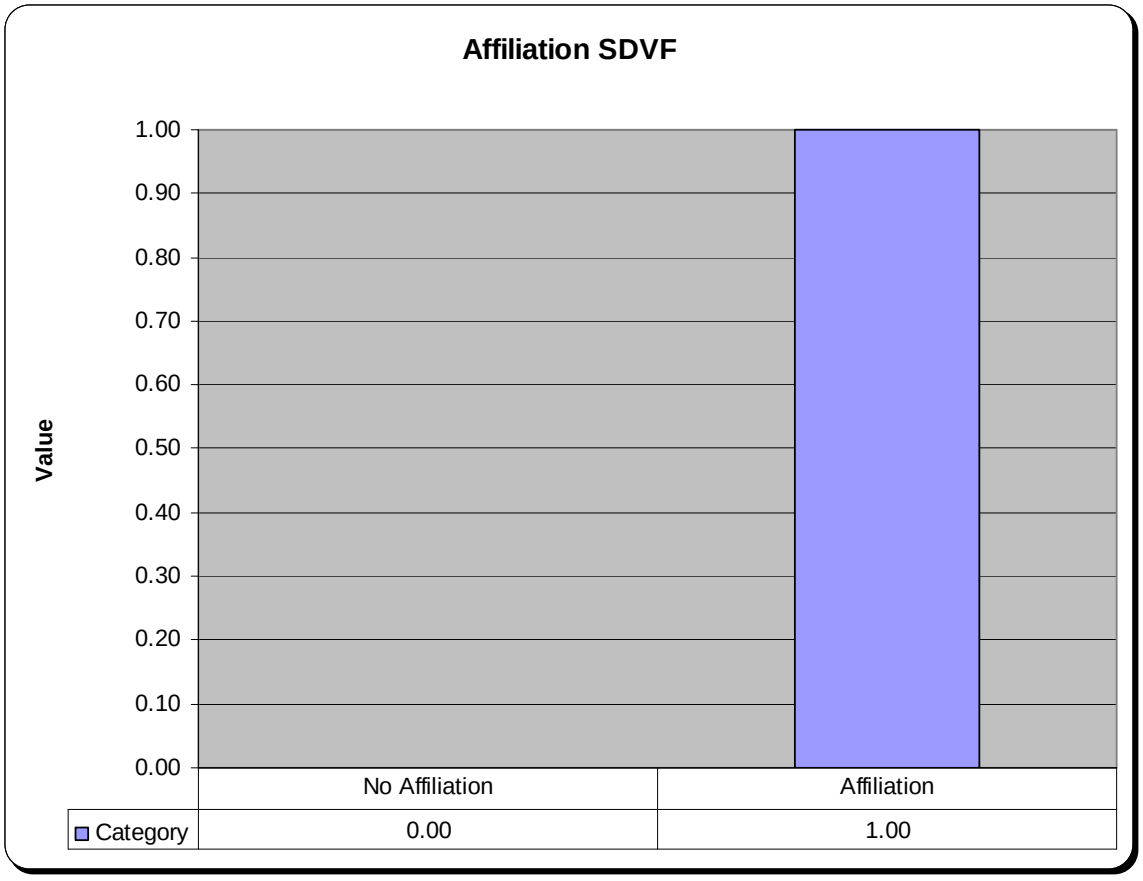


Figure 24. Affiliation SDVF

Gang Affiliation measure whether or not the child has any family member (1st cousin or closer) or household member that has past or present membership with a street gang. A child with a family member in a gang increases their likelihood to join a street gang as well.

Gang Affiliation is a categorical measure with only two choices: Affiliation or no affiliation.

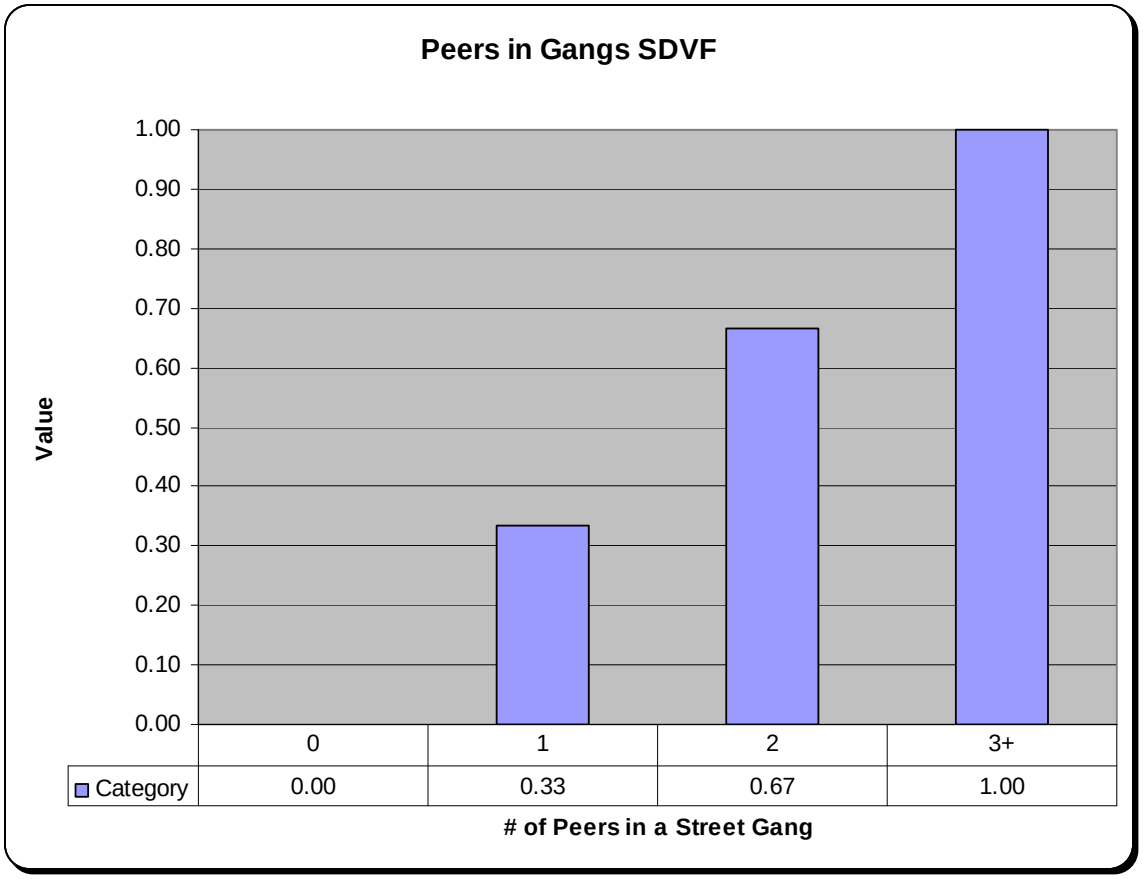


Figure 25. Peers in Gangs SDVF

Peers in Gangs considers the number of friends a child has that are currently members of a street gang. This measure captures the fact that children are often susceptible to peer pressure and tend to associate with individuals with similar interests. More friends in street gangs increases the likelihood the child will also join a street gang.

Peers in Gangs is represented as a linear function. It is important to note that only whole numbers are used in this SDVF. Therefore, the only numbers involved are 0, 1, 2, and 3. Any child that has 3 or more peers in a street gang receives a value of 1.

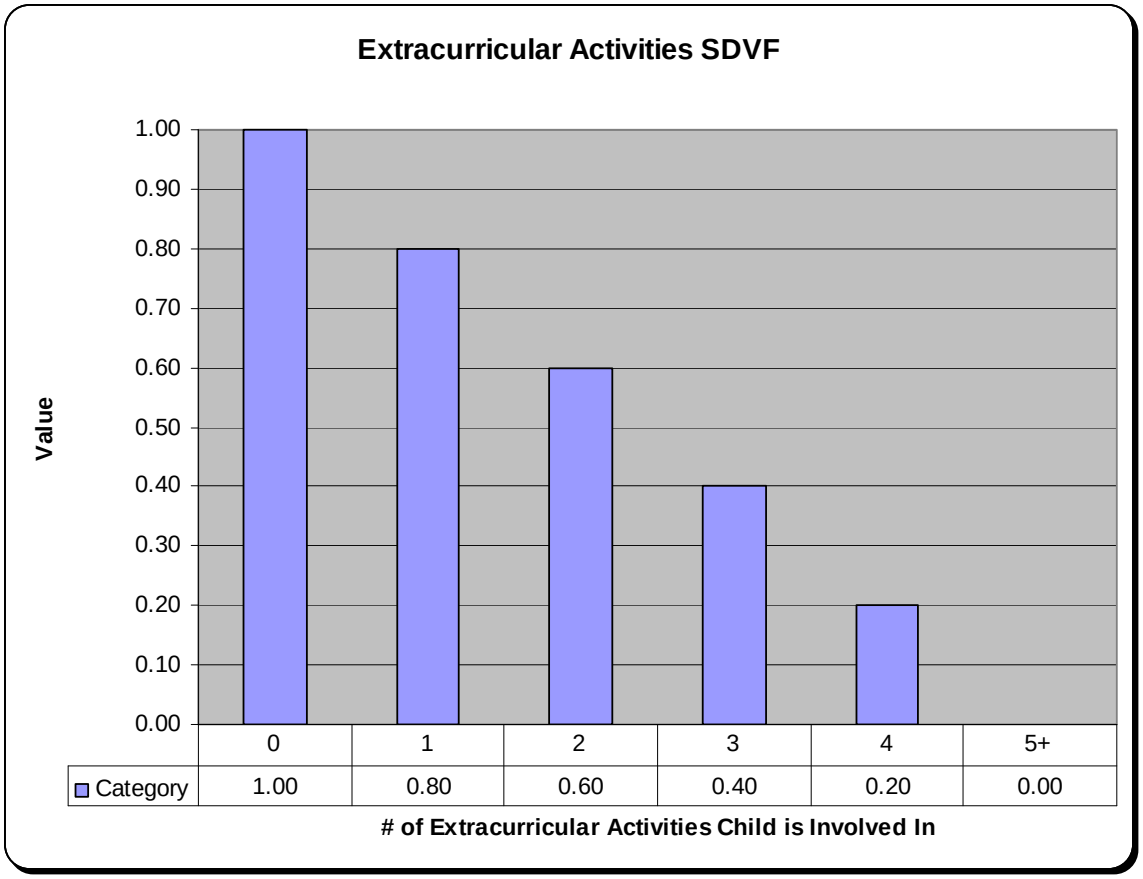


Figure 26. Extracurricular Activities SDVF

Extracurricular Activities is a proxy measure that captures feelings of outcast or loneliness experienced by a child. Typically, the more activities a child is involved, the more likely the child has friends and will not turn towards a street gang for companionship. Extracurricular activities consist of any activities school related or not.

Extracurricular Activities is represented as a linear function. It is important to note that only whole numbers are used in this SDVF. Therefore, the only numbers involved are 0, 1, 2, 3, 4, and 5. Any child that is involved in 5 or more extracurricular activities receives a value of 0.

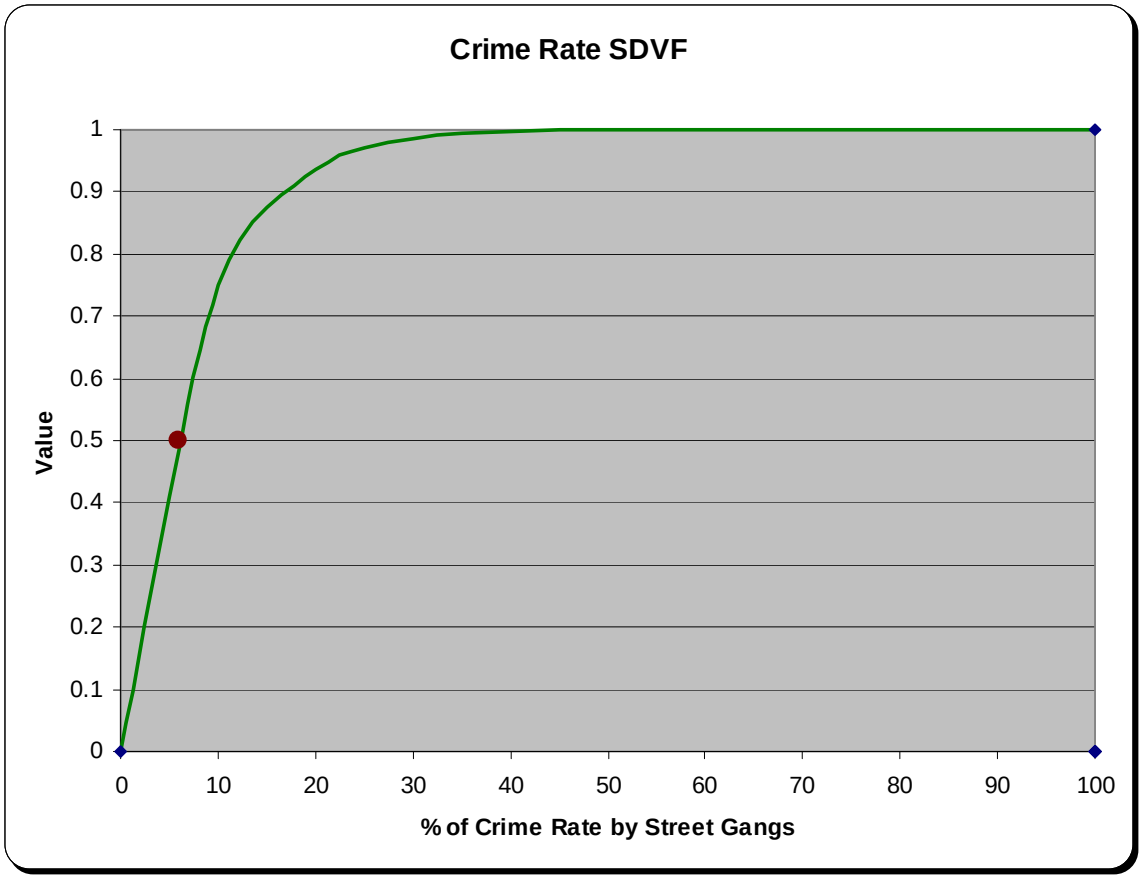


Figure 27. Crime Rate SDVF

Crime Rate is a measure that accounts for the amount of violent crime that street gang members are responsible for. This information is typically a lower bound since only reported crimes responsible by gang members is accounted. There may be more crimes that street gang members committed but is unknown to the police.

Crime Rate is measured using the exponential value function. The bounds are at 0% and 100%. The curve represents that "more is better" and has a midpoint at 5%.

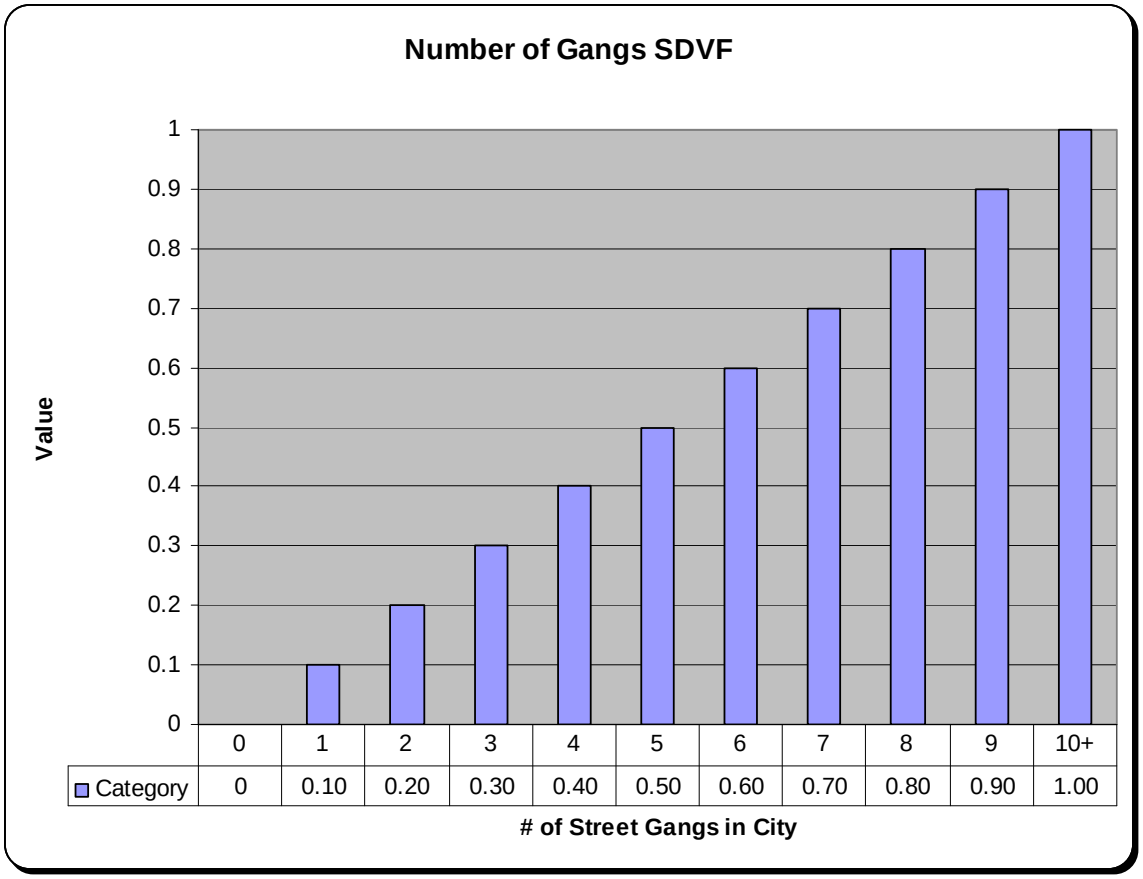


Figure 28. Number of Gangs SDVF

Number of Gangs measures whether or not there are gangs in the city. This is used along with Crime Rate to determine presence and magnitude of street gangs in a city. More gangs in the city increases a child's likelihood to be influenced to join a gang.

Number of Gangs is represented as a linear function. It is important to note that only whole numbers are used in this SDVF. Therefore, only whole numbers from 0 to 10 are used. Any child living in a city with 10 or more gangs is assigned a value of 1.

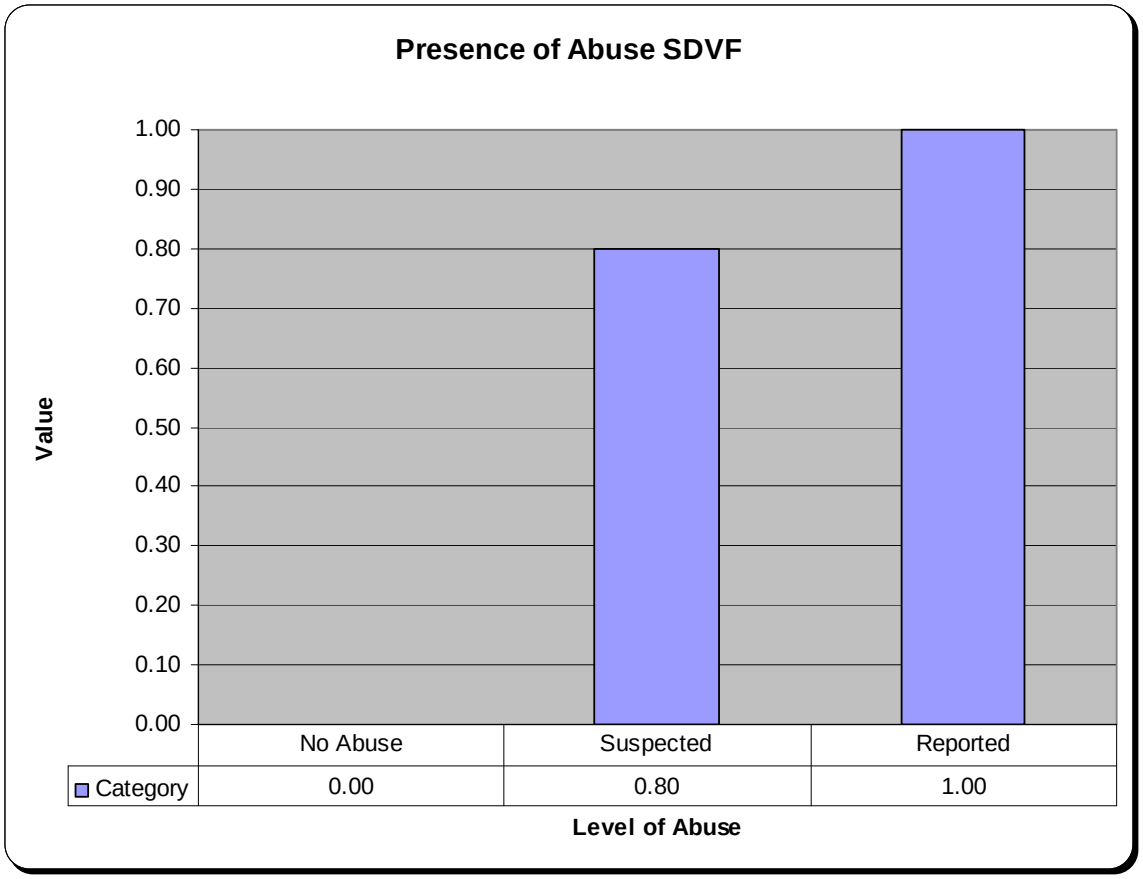


Figure 29. Presence of Abuse SDVF

Presence of Abuse measures whether or not the child has been alleged to be abused in the household. Abuse can come in the form of mental, physical, verbal, or sexual. No preference is given to what type of abuse exists in the household. Importance is placed on whether or not abuse has been reported in the household or is suspected by local law enforcement or other officials to exist in the household.

Presence of Abuse is a categorical measure with three choices: No abuse, suspected abuse, or reported abuse. The measure assumed that not much difference exists between suspected or reported abuse due to the strong evidence police usually have to suspect abuse in the household.

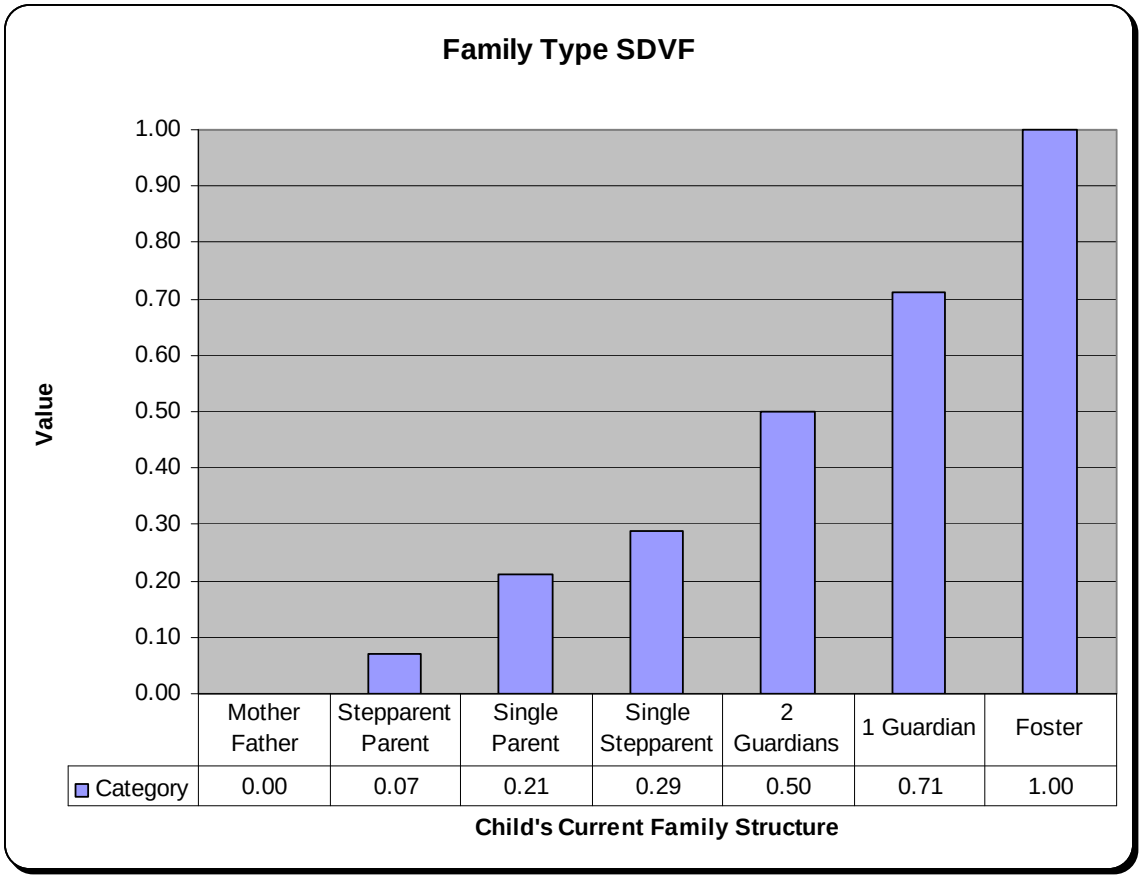


Figure 30. Family Type SDVF

Family Type measures the household structure in which the child currently resides. Only the current family type is chosen for the child since another evaluation measure accounts for changes in the family structure. Seven categories were chosen to represent most of the general family types that currently exist. The categories are not gender specific due to the model including both boys and girls and not distinguishing between the two groups. This simply means that there is no difference between having a single mother or a single father. Guardians can be any third party individuals that have taken custody and responsibility to care for the child, not those associated with the foster care system.

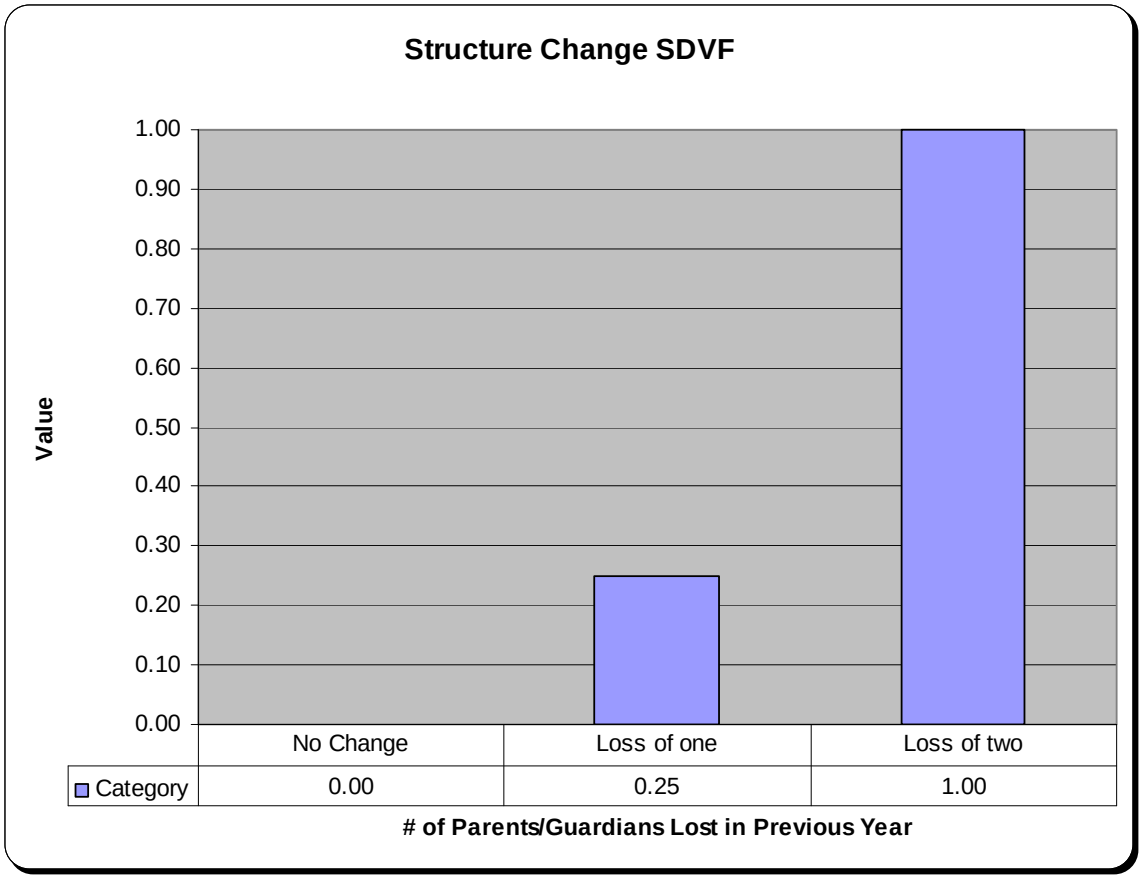


Figure 31. Structure Change SDVF

Structure Change measures whether or not the child lost a parent(s) or guardian(s) in the previous year. This loss can include death, divorce, abandonment, or any other reasons for the parent to no longer be in the household. Only the previous year is considered to capture changes in the child's behavior.

Structure Change is a categorical measure with three options: No change, loss of one parent/guardian, or loss of two parents/guardians. According to the DM, the most significant change causing a child to want to join a street gang comes when both parents/guardians leave the household.

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Vita

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14. ABSTRACT

Street gangs have plagued the United States for decades. One focus of current gang prevention efforts strives to reduce the number of new recruits to local street gangs. This research proposes the uses of modeling and decision analysis to aid in identifying potentially "at risk" children likely to join a street gang in an Ohio county. A stronger means of identification of "at risk" children can lead to a more efficient placement of resources to reduce the number of street gang recruits. The approach also aids in differentiating between neighborhoods to help focus efforts.

Information obtained from value-focused thinking (VFT) analysis is used to determine an allocation of six hypothetical gang prevention programs for an Ohio county. A notional knapsack analysis is performed to illustrate the potential notional percentage reduction of "at risk" children using the six hypothetical gang prevention programs within the seventeen cities of the county. Different notional scenarios are discussed and a notional scenario is recommended to demonstrate a potential use of the proposed model and operations research in general in the public sector areas.

15. SUBJECT TERMS

Decision Analysis, Value Focus Thinking (VFT), Street Gangs, Ishikawa Diagram, Knapsack

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