STRATEGIC LOCATIONS: AN OPTIMUM LOCATION ANALYSIS OF FITNESS FACILITIES WITHIN THE OKLAHOMA CITY AND TULSA URBAN AREAS

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CHAPTER I

INTRODUCTION

Rise of the Health and Fitness Market

During the 1960s and 1970s individual areas throughout the United States witnessed the emergence of large commercial fitness facilities open to the public. These facilities are commonly known today as health clubs, exercise facilities, or simply "the gym". In 1965, Gold's Gym, one of the leading international health club corporations today with over 500 facilities, opened its doors in Venice Beach, California, and was known as a place for the "serious" workout (Gold's Gym Enterprises Inc., 1999). Powerhouse Gym International, Inc. was founded in 1975 in Farmington Hills, Michigan, and quickly became a major competitor within the health club market. In later years, World Gym in Santa Monica, California, Lady of America in Ft. Lauderdale, Florida, and LifeQuest in Charleston, South Carolina, would join the increasing number of health club corporations that provided a professional exercising atmosphere in which to workout. Locations of these initial exercise centers in the United States are illustrated in Figure 1. However, these beginning facilities were located primarily within the coastal states, thus providing exercise services only to those within a close proximity to these areas.

Early Fitness Center Locations

Figure 1. Locations of Early Fitness Centers

Furthermore, patrons of these fitness clubs consisted mainly of serious body builders who lifted weights to train for competition rather than as a way towards an overall healthy way of life.

The 1980s saw dynamic changes occurring in health and fitness, most notably in exercise programs and the facilities supporting the enterprise. Realizing the need for serious fitness facilities worldwide, Gold's Gym began its Licensee program in 1980 (Gold's Gym Enterprises Inc., 1999). This became the foundation of its international franchising operations, and gave prospective business owners the chance to have their own business within the health club industry while spreading the corporation's name. Many other companies soon followed their example, and the diffusion of health clubs from its predominant setting in coastal states to the rest of the country was underway.

In 1983, health clubs and corporate fitness centers spent some $5 billion on facilities and equipment (Robey, 1985). This is equivalent to $7.6 billion in 1998, and the figure continues to rise. The number of fitness facilities grew from 200 in the mid-1970s to 7,000 in 1983 (Huntley, 1983). Health clubs were no longer designed solely for the professional athlete or body builder, but for the average citizen looking to integrate fitness into their lifestyle. With the increased popularity of the aerobic workout incorporated into many health club's exercise programs, fitness trends began to broaden during this time. The number of commercial fitness centers created to accommodate the growing percentage of the population wanting to join such health clubs also increased, to approximately 10,000 in 1988 (Loro, 1988).

Problem Statement

Access to fitness equipment at a nearby facility has become an amenity and an expectation for millions of Americans of all ages (Sporting Goods Manufacturers Association, 1999). With the continued expansion of competitive commercial health clubs nationwide, the strategic location of fitness facilities becomes important from an economic and geographic perspective.

While much literature has discussed various aspects of the fitness industry, including trends, technological innovations, demographic changes, and new health findings, little attention has been devoted to the actual geographic placement of fitness facilities. This research provides a foundation for the locational analysis of commercial health club and exercise businesses.

Purpose of Study

The purpose of this investigation is to discover the optimal location of a new fitness facility to better serve potential health club participants within the target market of the fitness industry. Specific research questions of this study include:

1. Do surrounding populations within 5 miles of existing fitness facilities represent the fitness industry's target market?
2. Is each existing facility's surrounding populace underserved or overserved in terms of fitness services provided by the commercial gym?
3. What is the optimal location of a new fitness facility within each study area based on any underserved population, present locations of health clubs, and demographic characteristics that support its existence?

The study areas for this research are located within the urban boundaries of Oklahoma City and Tulsa, Oklahoma. Geographic Information System (GIS) applications are utilized for demographic analysis of the target populations within the study areas, and underserved or overserved populations are calculated using carrying capacity of the total system of facilities. Finally, location-allocation concepts are implemented to deduce the optimal area(s) for a new fitness facility in each study region based on relevant demographic data and under-served population numbers.

Recent Findings within the Fitness Industry

Studies indicate that the fitness industry in the United States has become an increasingly important component of the sports and recreation field over the past decade. The growth of health clubs and fitness centers has flourished not only in the traditional commercial environment, but also in various other settings throughout the country including apartment buildings, hotels, hospitals, corporate offices and the college campus. According to a 1989 survey released by a New York City market-consulting firm, Americans spent $17.4 billion pursuing health and fitness during that year (Patton, et al., 1989). There were close to 12,000 health clubs in the United States with a total of 18.2 million members in 1993 (Goldman, 1994), and these numbers continued to rise to more than 22.5 million patrons in 1997 (Maguire, 1999). Much like the expanding interest in the sport of golf with 25 million participants in 1999 (National Golf Foundation, 1999), these statistics implicate a fitness "boom" in recent years. This represents the need for additional services to supply exercising environments for the rising demand.

Explanations for the increase in health club and fitness program membership vary. One such reason stems directly from studies conducted in the corporate domain, where evidence indicates exercise will likely improve on-the job productivity. Since the early 1980s. companies have implemented a preventive type of philosophy believing improved diet and health habits. combined with regular exercise, improve worker performance (Pehanich, 1982). The corporate fitness center industry generates more than $5 billion a year (SGMA, 1999). Many organizations anxious to maximize worker productivity provide group membership for their employees to the increasing numbers of health clubs that have sprung up in business areas.

Another explanation for the increase in health club facilities is the fact that the "baby boom" generation continues to participate in various fitness activities because of its concern about staying healthy and living longer. Recent studies from the Sporting Goods Manufacturing Association (SGMA), a North American trade association created to promote recreation and fitness, show increases in the number of physically active people aged 35 to 54 as well as increases in the percentage of those involved in fitness between the years 1987 to 1997 (Sporting Goods Manufacturers Association, 1999). This notion of prolonged health is further supported by the 1996 Surgeon General's Report on Physical Activity and Health which summarizes and endorses dozens of scientific studies illustrating how regular exercise can prevent disease and improve lives. All of these findings illustrate how the increasing need for exercise services makes the creation and placement of health clubs extremely important in today's physically active society. The information in this thesis extends the growing literature concerning the fitness industry, and adds valuable information to two key disciplines associated with this research: Economic and Sport Geographies.

The Significance of Economic and Sport Geography

Economic Geography

Economic geographers have conducted numerous studies that examine the importance of location on activities that possess an economic character. Generally, economic activities are of two common types: production and consumption (McCarty, Lindberg, 1966). The discipline of economic geography has historically explained the production locations of tangible items (commodities), non-tangible items (services), and the locations of consumption of those items by humankind. There are many diverse factors associated with production and consumptive patterns that influence the locations of phenomena.

The above framework is applied to all types of industries, markets, and areas providing some sort of service. Nevertheless, little examination has been undertaken concerning the locations of commercial fitness facilities, and their servicing of the physically active public, which has comprised a larger portion of the population within recent years (SGMA, 1999). This study implements locational techniques that have been addressed by other areas of economic geography, but are specific to the fitness industry and the placement of its exercising facilities.

Sport Geography

Sport geographers have studied many patterns and processes dealing with a variety of topics in sports and recreation. John Rooney, an American pioneer of the geographical study of sport, has written such books as A Geography of American Sport (1974) and The Recruiting Game (1987) that focus on the spatial aspects and expanding role of sport in American society at all levels of competition. John Bale, Rooney's European counterpart in sport geography, has also contributed to this field with books, including Sports Geography (1989) and Landscapes of Modern Sport: Sport, Politics, and Culture (1994).

Both authors have examined the importance of sport as a cultural activity and have given academic overviews of the impact of sport on the landscape and population. However, most of their work does not incorporate much information pertaining to the fitness industry and its place within America's sports culture. This study contributes valuable information concerning the fitness industry and its impact on the landscape. Furthermore, this research adds to the field of sport and recreation by providing insight into the location of exercise services and facilities, and uses optimal location procedures and location-allocation concepts to analyze fitness facility placement.

The Location Allocation Concept

Leon Cooper (1963) conducted one of the first geographical studies that addressed the location-allocation problem (LAP). Factors examined in his work investigate the location of each destination, the set of shipping costs for a region, and the requirements at each destination. These conditions then determined the number of sources (centers providing the goods or services in demand), the location of each source, and the capacity of each source. Since then, many variations of the model have been utilized to ascertain the number and location of sources, and the allocation of their product or services to consumers.

Studies allocating facilities associated with economic activity strive to discover one or more locations that will optimize some measure of efficacy for production or service provision. This has been prevalent in past studies concerning the placement of agricultural facilities, public service facilities, warehouse location, early settlement patterns, and a number of other areas where optimization of location was necessary. When analyzing the fitness industry, however, applications of location-allocation models to health club placement are seemingly nonexistent. This research utilizes a location-allocation methodology that is unique to the analysis and placement of new commercial fitness facilities.

Project Significance

Social, economic, and geographic factors all become a significant part of a health club's existence within an area, and these must be accounted for when analyzing the optimum location of the facilities. This has become an even greater issue as fitness centers advance deeper into urban settings to accommodate the corporate market. Managers and owners of health clubs must realize the importance of the facility's geographic position within a competitive market, and incorporate this with the relevance of demographic information.

Knowledge of the optimum location of a fitness facility will become increasingly important to health club corporations as the health club market continues to grow in popularity, and corporations compete with one another as the fitness movement pushes forward into the next millennium. Theoretical and case-specific models and techniques presented in this research provides fitness industry professionals with valuable locational information that will optimize effectiveness of services, maximize capital gains and membership totals for their businesses, and provide further scientific knowledge to the fitness industry and economic geography as a whole.

CHAPTER II

LITERATURE REVIEW

Although the majority of research in the fitness industry focuses on such topics as demographic changes, technological innovations, exercise trends and health findings, existing written works on the location and placement of commercial fitness facilities is limited. Most writings concerned with a commercial health club's final position in a market environment deal with general business, marketing and maintenance strategies, and not the systematic positioning of facilities specific to the health club market.

Two separate areas of research comprise this chapter. The first section describes written works that focus on several topics associated with the fitness industry, and the facilities that support the business. The second reviews optimal location concepts, and multiple studies that include location allocation models within their research that are pertinent to this study.

Fitness Industry Literature

Location of Fitness Service Facilities

The placement and construction of fitness facilities is increasingly important with a health club's success. This includes not only the facility itself, but other external factors as well, including parking lots, traffic flow, visibility, outdoor recreational zones and other areas associated with the structure. The literature on site selection of health club buildings and grounds; however, is limited to generalized procedures rather than scientific inquiry.

Sawyer and Smith (1999), professors of recreation and sport management. describe how fitness professionals should understand all aspects of facility planning and design when determining site selection. The authors provide an outline of the many considerations taken into account that include, but are not limited to:

1. Access to site.
2. Parking.
3. Utilities – water supply, sewage disposal, electric supply, telephone service, etc.
4. On-site sources of pollution.
5. Economic impact of a site location.
6. Land characteristics.
7. Easements and other legal restrictions.

Surveys and evaluations of existing facilities, feasibility studies, creations of floor plans, financial analyses, and design considerations are summarized in the research to assist in facility location.

Richard Gerson (1989), President of Gerson Goodson Performance Management, uses guidelines that follow a scientific method approach to marketing a new fitness facility. A hypothetical scenario is contrived, and is divided into several sections. By categorizing fitness industry research into (1) a company analysis, (2) an industry analysis, and (3) a market analysis, the author incorporates separate types of collected data to create a sample facility marketing plan. Demographic characteristics, market research, competitor analysis, program and service strategies, and promotional tactics are implemented to determine the status and future assessment of a newly located fitness facility.

Grantham, et al. (1998) review two specific areas pertinent to a fitness facility's location: economic factors and existing businesses. In terms of economic issues, the authors describe the concerns of developers when placing and constructing a facility. These include costs of materials, possible repairs to underlying infrastructure, land prices, and imposed taxes from the city. With respect to present businesses, Table 1 compares some distinct advantages and disadvantages with the purchase of an existing health club. Both sides should be equally weighed as they are remarkably important when considering either the acquirement of a previous establishment, or the generation of a new fitness facility.

The American College of Sports Medicine (ACSM) is one of the largest and most respected sports medicine and exercise science organizations in the world, and conducts numerous studies concerning multiple facets of the health club industry. ACSM (1992) provides a foundation for health and fitness facility standards, and identifies six fundamental principles to which all fitness facilities affiliated with the organization must adhere. The standards addressed by the association are appropriate emergency responsiveness, pre-activity screenings, suitable signage alerting, supervision for youth services, and conformity to all relevant laws, regulations, and published standards.

TABLE 1

ADVANTAGES AND DISADVANTAGES ASSOCIATED WITH THE PURCHASE OF AN EXISTING FITNESS FACILITY

ADVANTAGES	DISADVANTAGES
1. Greater likelihood of continued success	1. Inheritance of any ill will from past members toward previous owners
2. Has a proven location for successful operation	2. Existing facility may not conform to current industry standards
3. Need for up-front business planning is minimized	3. Staff members who are not assets are frequently inherited with the business
4. Existing business has an established membership	4. Inherited membership may not fit a changing marketplace
5. Financing can be accomplished with a single purchase transaction	5. Policies established by the new business may not be accepted by an existing membership

Source: Grantham, et al. (1998)

The ASCM also give an overview of safety and space allocation guidelines for external grounds surrounding the facility. These include specifications for driveways, illumination, parking allotment, and pedestrian walkways. Finally, the authors review accessibility standards adopted by the organization pertaining to the Americans Disabilities Act (ADA) of 1990. They address interior and exterior specifications that facilities must follow concerning such issues as entrances and exterior areas, floor surfaces, stairs, ramps and elevators, wall fixtures, toilets, lockers and showers, and emergency warning systems. All of these factors play important roles in the design, construction, and maintenance of the external grounds associated with a commercial fitness center.

Fitness Industry Trends

Research associated with trends of the health club market analyzes a number of significant patterns occurring throughout the industry. A report published by the SGMA (1999) provides a comprehensive analysis of present trends occurring in the industry. The first document focuses its findings to an eleven-year period within the United States from 1987 to 1997. A study of twelve key trends in fitness, a demographic report on seventeen fitness activities, an eleven year study of participation trends, and a report analyzing fitness equipment sales are included. Findings of the research conclude that health club popularity has broadened during the span of the study, with club membership rising from 13.8 million in 1987 to 22.5 million in 1997. Table 2 portrays the increase in fitness expenditures within recent years.

TABLE 2

ANNUAL RECEIPT FIGURES* OF PHYSICAL FITNESS FACILITIES:
1993 TO 1997

1993	1994	1995	1996	1997
3,961	4,033	4,412	4,975	5,713

* In millions of dollars

Source: SGMA (1999)

The authors also describe how a large portion of the population is incorporating exercise machines (cardiovascular and strength training machines) and free weights into their workouts. This has further implications for health club participation, and the need for facilities to support the growing numbers of people embracing the use of exercise equipment.

A second related document from the SGMA (1999) summarizes the present state of fitness enterprises in the sporting goods industry. The authors begin with an overview discussing industrial changes of manufacturers and marketers within the health club business, and how the over-saturation of retail selling space is a perplexing problem facing the industry. The document observes significant increases in both retail space per person (over 30%) and sales inefficiency (decline in sales per square foot) through the 1990s. The authors then describe various patterns occurring in the fitness industry, including demographic changes, increases in fitness equipment sales, and impacts of technology on the industry. Concluding the report are summaries of key trends in the commercial fitness and sporting goods sector, and new ideas for the future that support the notion of a growing market within the fitness industry.

In one of the earliest atlases of contemporary society, Weiss (1994), an award-winning journalist and marketing consultant, uses consumer mapping to reveal the relative popularity of products, trends, and issues of American society. The author examines consumption patterns to offer insights into the tastes and habits of the American population, and provides proof that where we live affects our attitudes toward what we buy. One particular section maps those people who buy home-gym equipment versus those who go overnight camping. The study illustrates that populations located in the Western, North Central and Northeastern portions of the United States are more apt to buy fitness equipment. This examination provides a geographical perspective depicting the regions where physical fitness activities are more prevalent within the United States, and how additional facilities are needed to serve the growing demand for exercising services.

In 1996, the United States Department of Health and Human Services (1996) released the first-ever report on physical activity and health. Undertaken by United States Surgeon General Audrey F. Manley, M.D., the study concludes that regular moderate physical activity offers substantial benefits in health and well being for the vast majority of Americans who are not physically active. It also states that regular moderate physical activity can substantially reduce the risk of developing or dying from heart disease, diabetes, colon cancer, and high blood pressure. Ten authorities on fitness and health participating in a survey by the SGMA (1999) said the document has a positive effect on the fitness industry. The findings within the report have long-term value because of the scientific and official endorsement they give to exercise.

Rodney Warnick (1994), professor of recreation studies at the University of Massachusetts at Amherst, discusses how fitness clubs may benefit from an improved knowledge of consumer shopping styles. Utilizing research methodology developed by Simmons Market Research Bureau (1987), data are compiled from a structured questionnaire, focusing only on the college student market. This is because the consumer group constitutes about one-fifth of all adults 18 years and older who participate in physical fitness programs. Descriptive statistics (percentages), chi-square analysis, and factor analysis examine shopping styles of the respondents, using a .05 level of significance; however, relationships at the .10 level are also reported.

The results of Warnick's study indicate that convenient location is presumably the most critical factor to consumers who enroll in exercise programs. Other determinants deemed important are whether the facility has the latest fitness trends and/or techniques, and if the program is economically feasible. This research shows implications for the trends that fitness center managers must be aware of, and provides insight to where health club facilities need to be located for successfully servicing the fitness consumer.

Demographic Patterns

The majority of research regarding the health club industry pertains to the demographic characteristics of fitness consumers. These are the most common traits used to segment a market; with age, gender, marital status, family size, personal and household income, people per household, education, and occupation constituting the primary demographics. Data collected from these categories reflect a composite of the typical consumer that comprises the industry's "target market." By general definition, a target market is composed of individuals or groups for which a service or product is intended.

The SGMA (1999) study on the fitness movement reviews the details of interviews given to 16 marketing and operating executives from leading fitness equipment manufacturers that discuss participation in the industry. Among the given responses, reasons fitness participation will continue to increase are:

1. Baby boomers wanting to delay the aging process.
2. Growing concerns about health in the aging population.
3. Vanity.

4. The continuing flow of information about the health benefits of exercise.

5. Concerns about "quality of life" – defined as a personal, emotional sense of well being.

6. The continuing proliferation of fitness facilities and the growing sense that having access to such a facility is one element in having a good life.

The authors state that in 1987, 18 to 34 year olds encompassed 52% of all members at health clubs. In 1997, the figure had dropped to 41%. This is an account of a continuing commitment to exercise from the oldest portion of the baby boomer population, who in 1997 were entering their 50s. Nevertheless, executives interviewed by the SGMA feel the health club industry is missing a major opportunity to capture more of the over-40 year old market.

The United States Bureau of the Census (1999) presents an extensive collection of statistics for the United States, with selected data for regions, divisions, states, metropolitan areas (MA's), cities, and foreign countries from reports and records of government and private organizations. The reference work contains numerous tables and charts illustrating statistical figures on the social, political, and economic aspects of American society. Table 3 summarizes a portion of the data describing those people who took part in four types of physical fitness activities from 52 selected sport activities in 1997.

Sports activities in the U.S. Census Bureau's statistical compilation are separated into two categories: Series I (31 activities) and Series II (21 activities). All activities are ranked on a numerical scale, from the most popular (1) to least popular (31 and 21 respectively).

TABLE 3

NUMBERS OF PARTICIPANTS* IN SELECTED FITNESS ACTIVITIES: 1997

TYPE OF EXERCISE	TOTAL PERSONS	AGE 18-24	AGE 25-34	AGE 35-44	HH INCOME 25,000-34,999	HH INCOME 35,000-49,999
Aerobic**	26,259	4,490	6,920	5,454	3,494	5,161
Exercise** with equipment	47,868	7,125	10,910	10,792	6,112	8,314
Running/** Jogging	21,688	4,008	4,664	3,884	2,437	3,577
Work out*** at club	21,128	4,203	6,059	4,286	2,758	3,428

* In thousands

** Series I sports (based on a sampling of 15,000 households)

*** Series II sports (based on a sampling of 20,000 households)

Source: United States Census Bureau (1999)

The results conclude that the four fitness activities had higher rankings than many of the activities within their group, especially exercising with equipment (3) and working out at a club (4). Data from this research also show increases in participants within the 25 to 34 and 35 to 44 age brackets. Furthermore, greater numbers of people that have higher household incomes partake in fitness activities. These findings represent important demographic characteristics essential to understanding those who are actively pursuing improved fitness in the health club industry.

Grantham, et al. (1998) discuss how tracking member profiles includes three demographic categories: gender distribution, age distribution, and household income. Findings of the work show that in 1997 women memberships were increasing annually at a higher percentage than male memberships, with 60 percent of women and 40 percent of men constituting the commercial fitness center market. However, the document also reviews commercial facility usage of men and women, citing males frequent the gym an average 88 days per year versus 82 days for females. In terms of age distribution, the authors state that 18 to 34 year-olds comprise the greatest percentage of total fitness participants (42%), with the 35 to 54 year-old category making up the second largest group (38%). However, the literature suggests that two groups showing the greatest potential for growth in the future are the under-18 age group and the senior market (over 55 years of age). Studies concerning household income determine that in 1996, 51% of the total population having commercial health club memberships earned between $25,000 to $74,999, while 33% of the total commercial health club market had an average household income over $75,000. This was in contrast to nonprofit fitness organizations, where 77% of members participating in health fitness activities had incomes between $25,000 to $74.999. Demographic information of this sort is vital to a fitness industry professional's decision of where the target market is positioned, and where locations of new facilities are practicable.

Marketing professors Granzin and Olsen (1989) investigate the relationship between voluntary commitment to physical fitness. The authors cite three categories of predictor variables: demographics, attitudes, and participation in leisure pursuits, explore voluntary commitment conceptually, and then operationalize voluntary commitment as membership in a health club or organized exercise class. The principal conclusions of the research are summarized as follows:

1. Involvement in fitness activities can be usefully considered in terms of voluntary commitment.

2. Commitment is empirically related to demographics, attitude, and both passive and active leisure pursuits.

3. Persons who commit to physical fitness programs have the characteristics of youth.

4. Persons who commit hold a self image of fitness and athletic ability, have been influenced by friends on how to spend their time, and have a higher level of self motivation and mental ability.

5. Persons who make a commitment to formal physical fitness programs are more involved in a variety of active and passive leisure pursuits.

The research provides useful information on determining the portion of the population that would voluntarily commit to physical fitness activities, and has a number of implications for health club professionals and managers who promote physical fitness programs.

Optimal Location Literature

Optimum Location Concepts

Background. The primary concern in optimal location problems is determining the best site(s) for one or more new facilities with respect to a set of fixed points, often called existing facilities, markets or users, sources or destinations, with which it (they) should interact (Plastria, 1995). Examples of interaction are movement of goods and/or services, communication lines, or attraction of potential customers. Additional considerations of the location problem include processing techniques, plant size, shipping standards, and the number of facilities required to either maximize profit or minimize costs for an entire service area.

In 1826, Von Thünen, a German agriculturist, made one of the first attempts to spatially model efficient location for agricultural production. His work focuses on first, a crop model, containing zonal organization of crops from a central market; and secondly, a model of intensity, where land-use intensity declines with distance from the market. Underlying assumptions of the model consist of an isotropic surface, a single market, uniform transportation, and the circumstance that all land will become available simultaneously. His work attempts to determine the kind of agricultural production to occur at different locations on a homogeneous plain, using as variables transportation costs, market price, distance from market, production costs, and yield.

Weber's (1909/1929) theory of industrial location assumes that industry will locate where the costs of production and distribution are minimized, with transportation being the most important of these costs (Healey, Ilbery, 1990). His work modifies von Thunen's ideas by inferring an uneven geographical distribution of raw materials, and incorporates a "materials index" to determine whether an industry is material or market oriented. His work contributes significant applications to service industries by determining optimal location of an individual business providing a specific activity.

Modern Research. Recent studies pertaining to optimal location problems cover a wide range of topics concerning facility placement. Plastria (1995) outlines solutions to general multi-facility location problems in continuous space.

Variables and constraints involved with the issue are addressed, and the general algorithm of the multi-facility location problem is presented:

$$MIN\{G(D(\chi)) \mid \chi \in S\}$$

where:

G = globalizing function

$D(\chi)$ = vector of distances

$\chi \in S$ = global constraint

The author discusses the use of minisum and minimax procedures in solving multi-facility location problems, and provides several sources that study additional solutions to optimizing a facility's location.

Tammy Drezner (1994), a professor of marketing, states that "Estimation of market share is used by marketers to evaluate a user provided a discrete set of potential sites for the location of a new facility within a matrix of existing facilities" (49). It is noted, however, that the best location for the new facility may not be included in the predetermined set of sites. The author studies the best location of a retail facility anywhere in a continuous plane by analyzing the market share function over the study area, and identifying the optimal location for a new facility within the service region.

Drezner divides the study area into smaller sectors, with demand points located at their centers, and creates an algorithm for the location solution using procedures that solve the minimization of the total weighted Euclidean distances. Three individual experiments conclude the study, illustrating (1) the ideal location for a new facility, (2) the capture of market share sensitivity, and (3) the best location and largest market share associated with the differences between existing and non-existing facilities belonging to a new facility's chain.

Myung, Kim, and Tcha (1997) present a bi-objective model for uncapacitated facility location. The objectives are to (1) maximize net profit, and (2) maximize profitability of investment. The structure of the model is characterized as having both a linear and a fractional objective function. A heuristic procedure is developed to explain computational advantages over existing procedures, and a numerical example is given to illustrate the solution process.

Two similar studies from Justice (1972) and Eshleman (1994) examine the optimal number, size, and location of agricultural facilities in Oklahoma. Both authors utilize statistical methods to reach such objectives as estimating operating costs of grain handling facilities, determining the optimum flow and mode of grain transport within Oklahoma, calculating the current cost of cotton transport, ginning, and warehousing, and ascertaining the optimum number, size, and location of cotton gins in Oklahoma needed to efficiently serve the needs of cotton producers.

Location Allocation Models

Background. There is not always a clear distinction between pure location problems where the central aim is to determine optimal site(s), and location allocation problems in which other aspects, such as resolve of "active" interactions (i.e. those which directly influence the global value of the solution), are an important part of the explanation to the impending issue (Plastria, 1995).

Cooper (1963) is credited with proposing one of the first geographical studies to address the location allocation (L-A) problem. The general concepts in his research investigates the given (1) location of each destination, (2) set of shipping costs for a region, and (3) requirements at each destination. These conditions then determine (1) the number of sources (centers providing the goods or services in demand), (2) the location of each source, and (3) the capacity of each source. This literature provides the foundation for numerous studies undertaken concerning the location allocation concept.

Rushton, Goodchild, and Ostresh (1973) organize a collection of computer programs used to determine optimal location patterns. Exact and heuristic methods are presented to solve one source, two source, M-center, and multiple facility location problems. Each solution technique is outlined as follows:

1. the problem
2. the algorithm
3. input
4. computation
5. output
6. time estimates
7. core limits
8. compatibility

All computerized versions of the algorithms are written in the FORTRAN programming language, and follow each set of solution procedures throughout the literature. This work is a comprehensive manual illustrating the functionality of early computer use for L-A problems.

Recent Applications. Contemporary location allocation models are applied to a number of diversified subjects concerning optimal location solutions. Ghosh and Craig (1984), of the New York University Graduate School of Business Administration, use an L-A model that identifies locational strategies for facilities in a competitive environment. The authors give a brief introduction describing past use of location allocation solutions in planning situations, but cite that most existing models deal exclusively with noncompetitive circumstances within the private sector. A competitive location model is applied to a sample study of retail convenience stores, which is "...characterized by a limited and very similar product offering across outlets" (41).

The authors utilize statistical equations to analyze a hypothetical scenario for stores A and B that applies the location allocation model to study such topics as sets of feasible sites, optimal store location, and optimal number of stores. Tables that accompany the text illustrate alternative strategies for expected profit and best location, and site identity for the two firms. This analysis is an important resource for examining facility location within a competitive market in the private sector.

Ruggles and Church (1996) combine the use of Geographic Information Systems (GIS) and an L-A model to analyze the regional settlement of the Late Horizon Basin of Mexico. A primary objective of the study is to investigate the feasibility and demonstrate the probable value of incorporating capabilities of GIS and L-A techniques to judge if the model-generated configurations replicate the empirical pattern of facilities (163). The research includes:

1. The use of a P-median problem (Weaver and Church, 1987) to consider the flow of surplus agricultural production and/or people through the environment.

2. The siting of twelve facilities, taking into account their intermediate hierarchical position and links to a larger exterior system.

3. The application of an L-A model to different estimates of agricultural productivity and road networks in order to investigate model sensitivity.

This study provides a unique methodology, illustrating how the combination of these two techniques is quite useful with solving certain spatial problems.

Research conducted by Pooler (1983) investigates the influence of study area scale on computer location allocation model effectiveness in the public sector problem (iii). The impact of scale on public facilities location is analyzed, and an L-A model examines optimization of the spatial organization and operation of services within the case studies of the Stillwater, Oklahoma, and Putnam City, Oklahoma elementary schools. The author clarifies the differences between the public and private sector environments by providing a list of attributes that explain the nature of public facility problems and its distinction from the private sector.

Pappis and Karacapilidis (1994) develop a decision support system (DSS) to apply the service level criterion in an L-A problem. Rather than providing an exact optimizing solution, the DSS produces a set of aids to assist in relating the values of the decision criteria used as well as other parameters associated with the results of the implied resolutions. Diagrams illustrate existing and proposed distribution systems, and numerous tables summarize the calculations of algorithms presented that compute the distance limit between a customer and the nearest supplying center (the variable *dist*). This research has important implications for the competitive positioning of a business at the service level, which is fundamental for marketing strategies.

Logendran (1984) and Abtahi (1989), former doctoral students at Oklahoma State University, conducted similar studies focusing on plant location allocation in the presence of stochastic demand. Both authors describe its importance when the demand at destinations for specific consumer goods is unknown, by providing a greater element of reality into the analysis of the problem (Abtahi, 1989). This is valuable when considering demand uncertainties related to those aspiring towards a health lifestyle.

Ross, Rosenberg, and Pross (1994) apply an L-A model to consider the optimal location of a second breast cancer screening facility, and to compare the distribution of services within the study region of eastern Ontario, Canada. An algorithm developed by Goodchild and Noronha (1983) based on the Teitz and Bart (1968) algorithm is incorporated into the solution. The authors state that given a network of N demand nodes with M candidates as selection of centers, and given the M x N matrix of shortest paths between demand nodes and candidates, the algorithm makes a systematic search for the subset of P candidate nodes which optimize an objective function. The objective function is as follows:

$$\text{MIN} \sum_{i,j} x_{ij} c_{ij}$$

where:

x_{ij} = the population at place i allocated to location j;

c_{ij} = a constraint term which may be modified to solve one of four

problems:

Min. total distance	$c_{ij} = w_i\, d_{ij}$;
Min. maximum distance	$c_{ij} = w_i d_{ij}$ if $d_{ij} \leq S$, L otherwise
Max. coverage	$c_{ij} = -w_i$ if $d_{ij} > S$, 0 otherwise
Min. total distance subject to a distance constraint	$c_{ij} = w_i d_{ij}$ if $d_{ij} \leq S$, L otherwise

where:

w_i = people at place i;

d_{ij} = the distance between places i and j;

S = a specified distance from a service;

L = a large number. Solve repeatedly, reducing S until a solution is infeasible

Three figures representing the study areas, a chart tracking target population growth, and tables evaluating seven different scenarios present a number of findings concerning the future placement of mammography screening services in eastern Ontario, Canada. This research has important implications for health services, and provides a good framework for additional location allocation studies within the industry.

Summary

As previously stated, the majority of research in the fitness industry focuses on such topics as exercise trends, demographic changes, health findings, and technological innovations rather than the optimal location of commercial fitness facilities. In fact, to the best of the author's knowledge, the use of location allocation models regarding the optimum location of facilities within the fitness industry is nonexistent. Thus, this study incorporates optimal location and location allocation concepts into its research to better understand the nature of facility placement in the health club market.

CHAPTER III

DESCRIPTION OF STUDY

Research Purpose and Objectives

The purpose of this research was to discover the optimal location of a new fitness facility in both the Oklahoma City and Tulsa urban areas to better serve potential health club participants within the target market. More specifically, this study addressed the following research questions:

1. Do surrounding populations within 5 miles of existing fitness centers represent the fitness industry's target market?
2. Is each facility's surrounding populace underserved or overserved in terms of fitness services provided by the commercial gym?
3. What is the optimal location of a new fitness facility within each study area based on underserved population numbers, present locations of health clubs, and demographic data that support health club existence?

Scope of Study Areas

The study areas for this research are located in the State of Oklahoma, more specifically within the urban areas of Oklahoma City and Tulsa. Figure 2 portrays these urban designations, as defined by the 1997 National Transportation Atlas Database from the Bureau of Transportation Statistics (U.S. Department of Transportation, 1997).

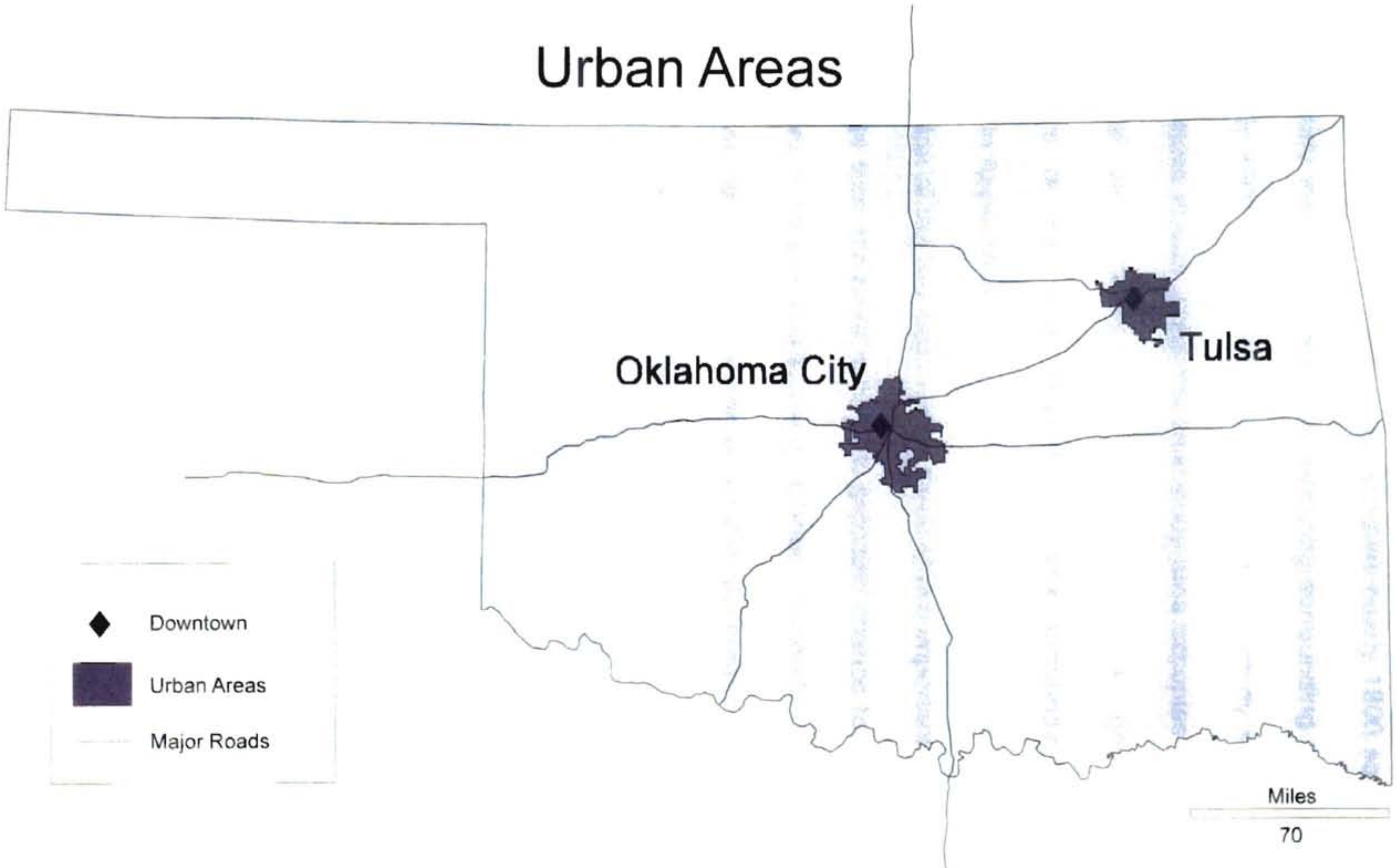

Figure 2. Oklahoma City and Tulsa Urban Boundaries

These study areas comprise the two largest metropolitan regions in the state. The Oklahoma City urban zone occupies nearly 1800 square miles, while the entire study area of this research, including surrounding zip codes, occupies approximately 8000 square miles. The Tulsa urban study site is approximately 900 square miles in size, while the total study area occupies nearly 4500 square miles. Total areas of the study sites, as well as general demographic characteristics of the urban designations and surrounding zip codes, are summarized in Appendix A.

Selection of the two cities was a result of two important factors. First, their relatively large size attributed to a more probable chance for greater numbers of fitness facilities to be available to the population. Secondly, on-site evaluations of existing fitness facilities were more accessible because of their relatively close distance to the author and to each other.

The study areas were disaggregated to 1999 zip codes. Demographic and underserved studies included in this research analyzed a surrounding distance of five miles from the existing facilities. This distance was chosen because of research suggesting that most gym members will usually travel no more than approximately five miles to their respective fitness centers to work out (Sallis, Hovell, & Hofstetter, 1990). Optimal location analysis of new fitness facilities extended to 12 miles from existing exercise facilities, as shown in the accompanying figures throughout the study. This was to account for populations within the urban designation that might need exercise services, but were not within the surrounding 5-mile area of existing facilities.

Data Collection Methods

Location of Existing Facilities

The Oklahoma City and Tulsa phone books, Internet resources, and on-site visits were utilized to locate existing commercial fitness facilities within the study areas. Commercial fitness facilities in this study were classified as those facilities owned by private enterprises primarily providing weightlifting and cardiovascular exercise services to the public for a fee. On-site evaluations determined whether the inclusion of selected gyms from the previously described sources fit the classification scheme, at the author's discretion. This was to eliminate specialized fitness service centers that only offer such single-purpose activities as jazzercise, kickboxing, yoga, and the increasingly popular "Tai Bo" workout.

Selection of Demographic Variables

Commercial demographic data packages and available United States Census data contained 1999 demographic information that was analyzed for each zip code in the study. The demographic variables corresponded with research discussed in Chapter II pertaining to the fitness industry's target market, and were combined with responses from letters sent to selected national fitness corporations to collect site-specific data. These national fitness corporations are listed in Appendix B.

As previously explained, a target market is composed of individuals or groups for which a service or product is intended. Specifically, it refers to a group of prospective consumers who can be distinguished from other customers by a set of unique characteristics (Grantham et al., 1998). Contemporary studies describe the typical American fitness consumer as college educated, under 40 years of age, in the middle or upper income bracket, working in a professional, business, or white-collar occupation, and living in the Northeastern or Western parts of the United States (Robey, 1985). The demographic variables in this research included:

1. Age – the range was between 25 to 44 years for this research to represent the largest percentage of consumers in the fitness market that frequent commercial fitness facilities.

2. Household income – studies suggest that the higher a household's income, the more likely person's within the household will use health club facilities. This research used a median household income of $35,000 or higher.

3. Education – fitness facility use is also attributed to a higher education. Median years of schooling was employed to represent this demographic variable.

4. Occupational status – this category was divided into white collar/blue collar workers. Studies imply that white-collar workers use the gym more often than blue-collar workers.

5. Marital status – this category was divided into single/married. Research suggests that single people frequent the gym more often than their married counterparts.

Research findings of fitness consumer demographics explain that these five characteristics are very important to understanding what portion of the population drive the commercial exercise market.

Manipulation of Data

Existing Facility Analysis

A Geographic Information System (GIS) database was first created in the ArcView GIS software package to store the demographic data collected, and all information of this type was organized and linked to the zip codes of the study areas. Attributes of each gym were included in the database and connected to locations of existing health club sites, represented by symbols on the maps included in the research. Appendix C summarizes the characteristics associated with the gyms. Utilizing GIS applications, zip codes within a surrounding 5-mile distance from each facility were selected to analyze the demographic characteristics of their populations. This distance was chosen to encompass both entire study areas, and because of research suggesting that most gym members will usually travel no more than approximately five miles to their respective fitness centers to workout (Sallis, Hovell, & Hofstetter, 1990). Visual interpretation and demographic analysis of created maps answered the first research question of the study, which is discussed in Chapter IV.

Population Service Analysis

To investigate whether the target populations were underserved or overserved for the study areas, carrying capacity for the number of customers that could be served for all existing fitness facilities was calculated. Although both cases of under and overservedness were computed, the research focused on underserved populations within the study areas. This was to justify the need for additional new fitness facilities in the urbanized designations, and for the use of underserved population numbers in the optimal location algorithm, as discussed later in this chapter. Therefore, overserved populations values were included in the accompanying tables of Chapter IV, but omitted from further inquiry pertaining to optimal location analysis of new exercise centers.

Two distinct scenarios were built for both the Oklahoma City and Tulsa studies that incorporated the percentage of people who work out at a health club a certain number of days a week. The two cases for each study area applied (1) actual percentages of people that workout three times a week (U.S. Bureau of the Census, 1999), and (2) anticipated percentages of people who exercise the standard amount of three times a week (Grantham et al., 1998). This was to represent actual population numbers using gym facilities, and to analyze hypothetical models of possible health club participants.

It is important to note that this component of the research assumed that people within the target market desire to exercise at a commercial facility, and are willing to pay for its services. In addition, the population figures for both scenarios were based only on the age variable because of research stating its importance as the major predictor for fitness activities (Robinson, 1987).

The first portion of the procedure determined the number of fitness participants that would use each gym. Population totals of the target market (age 25 to 44) within a 5-mile buffer of each gym were collected from the GIS database. Possible gym participants for the scenarios in both study areas were calculated using population totals, percentage of fitness consumers, and the number of times a week they frequent the health club. This is represented by the formula:

$$G_t = (P_t R) D \quad (1)$$

where:

G_t = total number of possible gym participants at facility t

P_t = population of target market within 5-mile buffer of facility t

R = percentage of people within target market that might go to the gym

D = number of days a week that people might utilize the gym

This operation was used in both the factual and hypothetical percentage scenarios to calculate the number of people within the target market that would frequent each separate gym.

The next operation determined the total capacity for each facility in one week of operation:

$$W_t = (C_t H) D \quad (2)$$

where:

W_t = total capacity in one week of operation for facility t

C_t = maximum capacity of facility t at any one time. Capacity in this instance was defined as the number of weightlifting and cardiovascular machines and areas (stations) multiplied by the percentage of people using and waiting for the exercise station (150%). This figure was chosen because it most accurately represented the number of people that would be in the facility during hours of operation

H = the average number of operating hours for the fitness facility (14)

D = the number of days of fitness facility operation in one week (7)

Finally, the following equation represented the amount of underserved people within the target market in a surrounding 5-mile buffer from each fitness facility *t*:

$$U_t = W_t - G_t \quad (3)$$

where:

U_t = underserved people within the target market in a surrounding 5-mile buffer from each facility *t*

W_t = total capacity in one week of operation for facility *t* (from Equation 2)

G_t = total number of possible gym participants at facility *t* (from Equation 1)

This was calculated and summarized for the existent and hypothetical scenarios of the Oklahoma City and Tulsa urban areas, and is discussed in the following chapter.

Optimal Location Analysis

Assumptions. The assumptions of the optimization model were as follows:

1. There are no restrictions on permissible capacities;
2. all locations within the study areas are technically possible or *feasible* locations;
3. all zip codes and quadrats in the study areas contain a uniform and even population distributions; and
4. there are no transport costs throughout the study areas.

Model Formulation. One square mile quadrats, based on Township and Range areas created from the Digital Atlas of Oklahoma, were used to divide the zip codes for closer analysis. To examine the areal locations most suitable for the placement of a new fitness facility, an equation was formulated to assign weighting factors to the demographic variables contained in each quadrat:

$$F_q = D(R_p + R_i + R_s + R_c + R_m)\, U_t \tag{4}$$

where:

F_q = the calculated value of quadrat q

D = the distance of the quadrats' centroids from the facilities

R_p = the ratio of the target population of the quadrat to the entire population of the study area, multiplied by a weighting factor (a)

R_i = the ratio of the median income of the quadrat to the average median income of the entire study area, multiplied by a weighting factor (b)

R_s = the ratio of the median years of schooling of the quadrat to the average median years of schooling of the entire study area, multiplied by a weighting factor (c)

R_c = the ratio of white-collar/blue-collar workers of the quadrat to the ratio of white-collar/blue-collar workers of the entire study area, multiplied by a weighting factor (d)

R_m = the ratio of married/single people of the quadrat to the ratio of married/single people of the entire study area, multiplied by a weighting factor (e)

U_t = amount of underserved people of the quadrat to nearest facility t

This equation gave each quadrat a unique value, which was then analyzed using ArcView GIS mapping applications to determine where the best area to locate a new fitness facility would be.

R-values of the variable ratios for each quadrat had a benchmark of 1, representing the typical value for each demographic characteristic. Values under this figure were less than the citywide average and values over it were greater than the citywide average for the individual demographic variable. This research focused on those R-values that were greater than the citywide average, which indicated a potential need for additional fitness service facilities.

The additional weighting factors (*a-e*) varied the importance of each particular variable. The first procedure assumed an equal distribution of weights, and the second assumed an unequal distribution determined by the author and guided by past research concerning the importance of those particular demographic variables. The variables were modified for the unequal weightings to determine whether the importance of one variable over another had an affect on the location of the new facilities. In both cases, the summation of the weights equaled 100.

Ordinal scales were created to represent distance and under-served population values in both study areas. This was for hypothetical model creation, and to simplify the use of actual distances and underserved populations of the quadrats from the existing facilities. In both instances, a higher scale value represents a more favorable instance for each particular case. Chapter IV discusses the results of the three separate analyses concerning (1) locations of existing facilities, (2) population service by the facilities and (3) the best areal location for new fitness facilities in the two study areas.

CHAPTER IV

DATA ANALYSIS AND RESULTS

This chapter provides the separate analyses and results of the study. Each section utilizes the generalized models discussed in Chapter III, and uses site-specific data collected for this study to answer the three research questions.

Analysis of Existing Fitness Facilities

Analysis

A total count of 75 zip codes for Oklahoma City, and 49 for Tulsa were incorporated to encompass the selected 12-mile surrounding area from the facilities. The GIS was configured to select zip codes within a 5-mile distance from each facility for demographic analysis of their populations. The first research question was then answered by determining if facilities were positioned where the surrounding 5-mile population represented the target market. Analysis of the desired demographic variables for the research included:

1. Percentage of potential member age group of 25 to 44 years ≥ national average of 12%.
2. Median household income ≥ $35,000.
3. Median years of schooling ≥ 13.5 years (1.5 years of college).
4. Greater proportion of white-collar workers to blue-collar workers.
5. Greater proportion of single people to married people.

Tables 4 and 5 list the selected health club establishments used in the research.

TABLE 4

LIST OF OKLAHOMA CITY FITNESS FACILITIES

Gym	Map Symbol*
1. Bodies By Ray Inc.	A
2. The Health Club	B
3. TLC Fitness Center	C
4. Mid-America Athletic Club	D
5. Pinnacle Fitness & Training	E
6. Pacer Fitness Center	F
7. Weight Room - 24 Hours	G
8. Cagle's USA Fitness Center	H
9. Cagle's Southern Athletic Club	I
10. All American Fitness Center	J
11. All American Fitness Center	K
12. Gold's Gym	L
13. Gold's Gym	M
14. Adams Course	N
15. The Athletic Club (TAC)	O

* Corresponds with letter in Figures 3,5,7,9,11,13,15,17,19,21,23,25,27

TABLE 5

LIST OF TULSA FITNESS FACILITIES

Gym	Map Symbol*
1. Bear's Gym	A
2. Body By Michael	B
3. East Side Gym	C
4. Healthwell	D
5. Mikey's Gym & Health Food	E
6. Physical Edge	F
7. Planet Fitness	G
8. Tulsa Athletic Club (TAC II)	H
9. Tulsa Athletic Club (TAC I)	I
10. Gold's Gym	J
11. Bally Total Fitness	K
12. All American Fitness Center	L
13. All American Fitness Center	M
14. All American Fitness Center	N

* Corresponds with letter in Figures 4,6,8,10,12,14,16,18,20.22,24,26,28

Results

Figures 3 and 4 illustrate the locations of existing fitness facilities within the two study areas, and the surrounding zip codes of the facilities. The maps show a cluster of gyms in the Northwestern sector of the Oklahoma City urban area, and a cluster of gyms in the central portion of the Tulsa urban area.

Tables 6 and 7 summarize total outcomes in reference to demographic analysis of the surrounding 5-mile zip codes from each fitness facility. Percentage of the desired age group was calculated by dividing the number of people within the target age range (25 to 44 years) by the total numbers of people residing in the surrounding zip codes. In every instance, 30% of the surrounding 5-mile population from each facility consisted of the target age group. This showed a relatively even distribution concerning age characteristics of the target market within the urban designations.

Median household income of the surrounding zip codes of fitness facilities in Oklahoma City and Tulsa ranged from $23,485 to $45,984 and $29,308 to $46,163 respectively. Figures 5 and 6 show the distribution of income levels for the zip codes within the 12-mile area. As the maps illustrate, a majority of the surrounding zip codes contained households making $35,000 or more. There was, however, a concentration of zip codes with incomes below this figure in the central section of the Oklahoma City urban area, and in the Northern parts of Tulsa. It is also important to note that within these areas there existed only 4 of 15 and 4 of 14 gyms respectively.

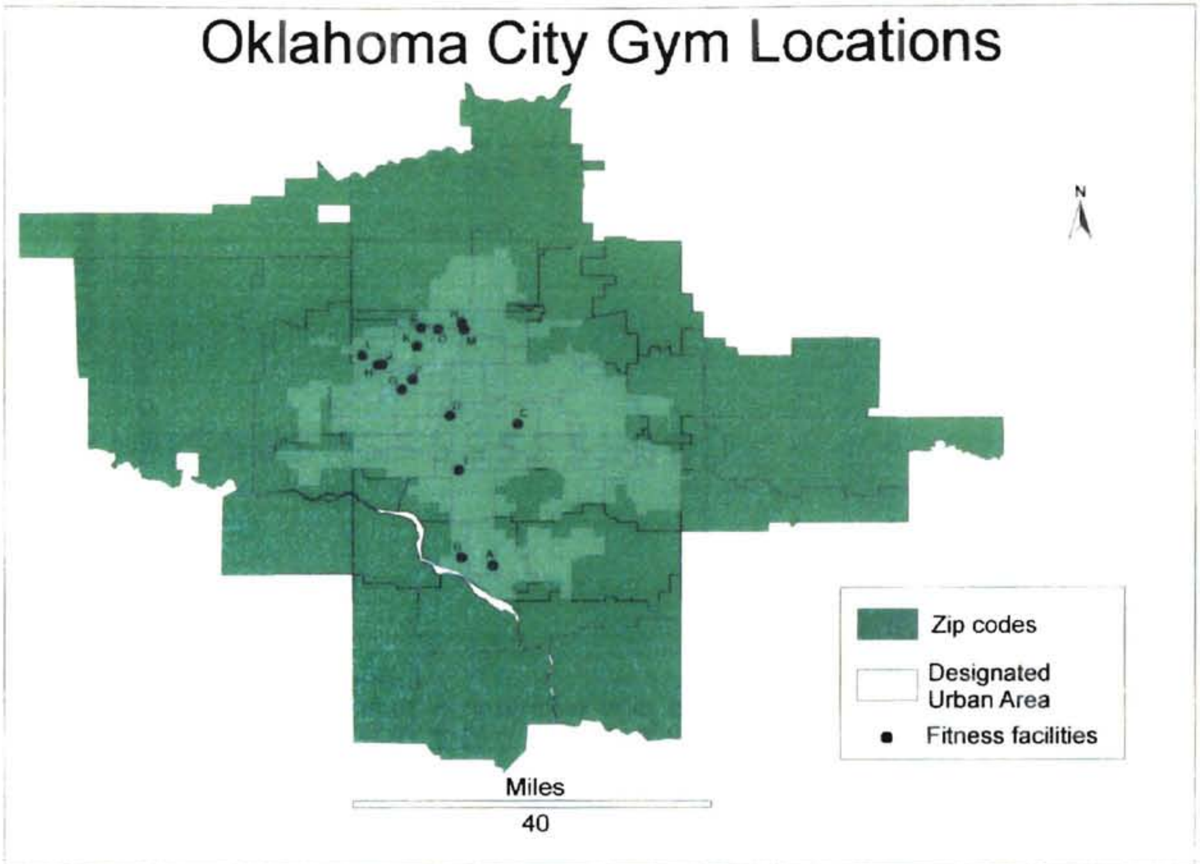

Figure 3. Location of Oklahoma City Gyms and Surrounding Zip Codes

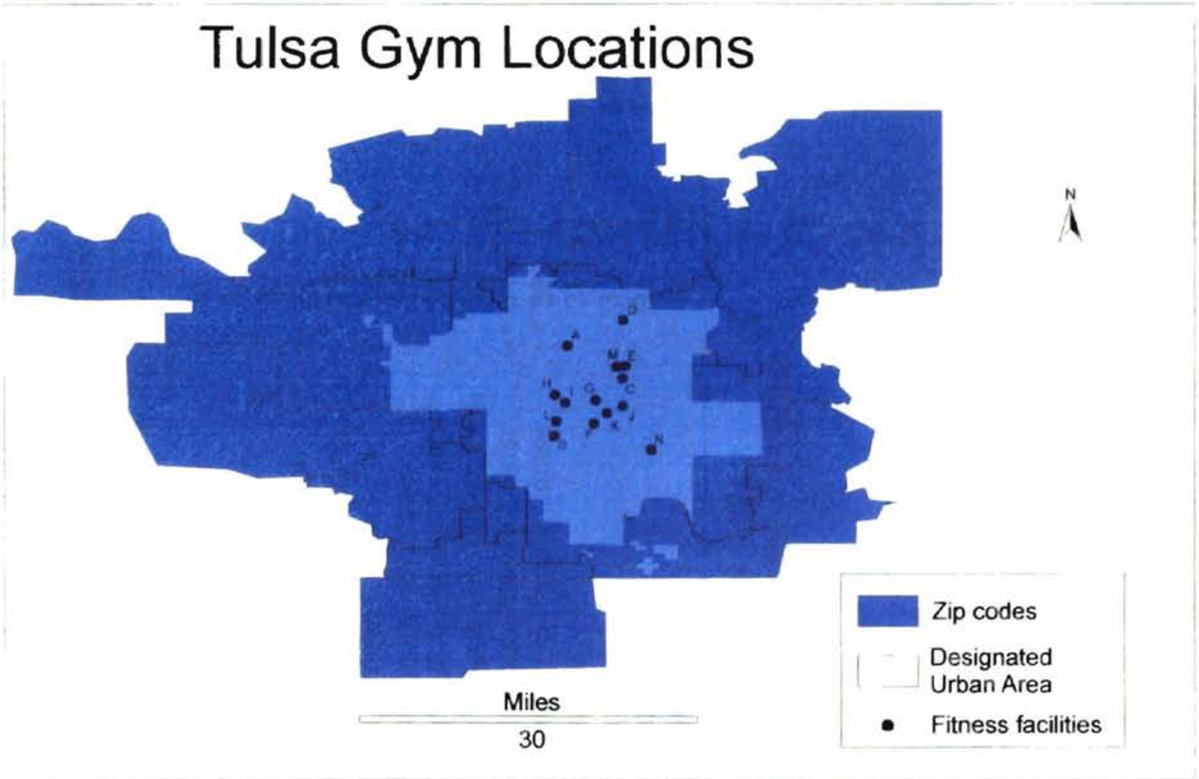

Figure 4. Location of Tulsa Gyms and Surrounding Zip Codes

TABLE 6

SUMMARY OF DEMOGRAPHIC STATISTICS FOR 5-MILE AREA FROM EACH FACILITY: OKLAHOMA CITY

Gym	% Target Age	Avg. Med. HH Income	Avg. Med. School	Marital Ratio M/S*	Occupation Ratio W/B**
Bodies By Ray Inc.	32	$40,537	14.0	1/1	3/1
The Health Club	32	$40,537	14.0	1/1	3/1
TLC Fitness Center	29	$29,148	12.6	1/1	3/1
Mid-America Athletic Club	30	$23,485	12.8	1/1	2/1
Pinnacle Fitness & Training	32	$45,984	15.2	2/1	6/1
Pacer Fitness Center	31	$30,272	13.3	1/1	4/1
Weight Room - 24 Hours	31	$30,338	13.5	1/1	4/1
Cagle's USA Fitness Center	31	$44,548	14.1	1/1	4/1
Cagle's Southern Athletic Club	30	$25,250	12.3	1/1	2/1
All American Fitness Center	31	$44,548	14.6	1/1	4/1
All American Fitness Center	32	$44,548	14.6	1/1	5/1
Gold's Gym	31	$44,548	14.6	1/1	5/1
Gold's Gym	31	$45,984	14.9	1/1	5/1
Adams Course	31	$45.984	14.9	2/1	5/1
The Athletic Club	31	$45.984	15.0	1/1	5/1

* married versus single

** white-collar versus blue-collar

TABLE 7

SUMMARY OF DEMOGRAPHIC STATISTICS FOR 5-MILE AREA FROM EACH FACILITY: TULSA

Gym	% Target Age	Avg. Med. HH Income	Avg. Med. School	Marital Ratio M/S*	Occupation Ratio W/B**
Bear's Gym	30	$29,308	12.9	1/1	2/1
Body By Michael	31	$40,672	14.5	1/1	5/1
East Side Gym	31	$37,420	13.2	1/1	3/1
Healthwell	30	$31,586	12.7	1/1	2/1
Mikey's Gym and Health Food	31	$38,043	13.2	1/1	3/1
Physical Edge	32	$40,672	14.5	1/1	5/1
Planet Fitness	32	$37,420	13.4	1/1	3/1
Tulsa Athletic Club (TAC II)	31	$31,586	13.4	1/1	3/1
Tulsa Athletic Club (TAC I)	31	$35,321	13.4	1/1	3/1
Gold's Gym	31	$38,043	13.5	1/1	4/1
Bally Total Fitness	31	$38,043	14.3	1/1	4/1
All American Fitness Center	31	$37,420	14.4	1/1	4/1
All American Fitness Center	31	$38,043	13.2	1/1	3/1
All American Fitness Center	32	$46,163	13.5	1/1	4/1

* married versus single

** white-collar versus blue-collar

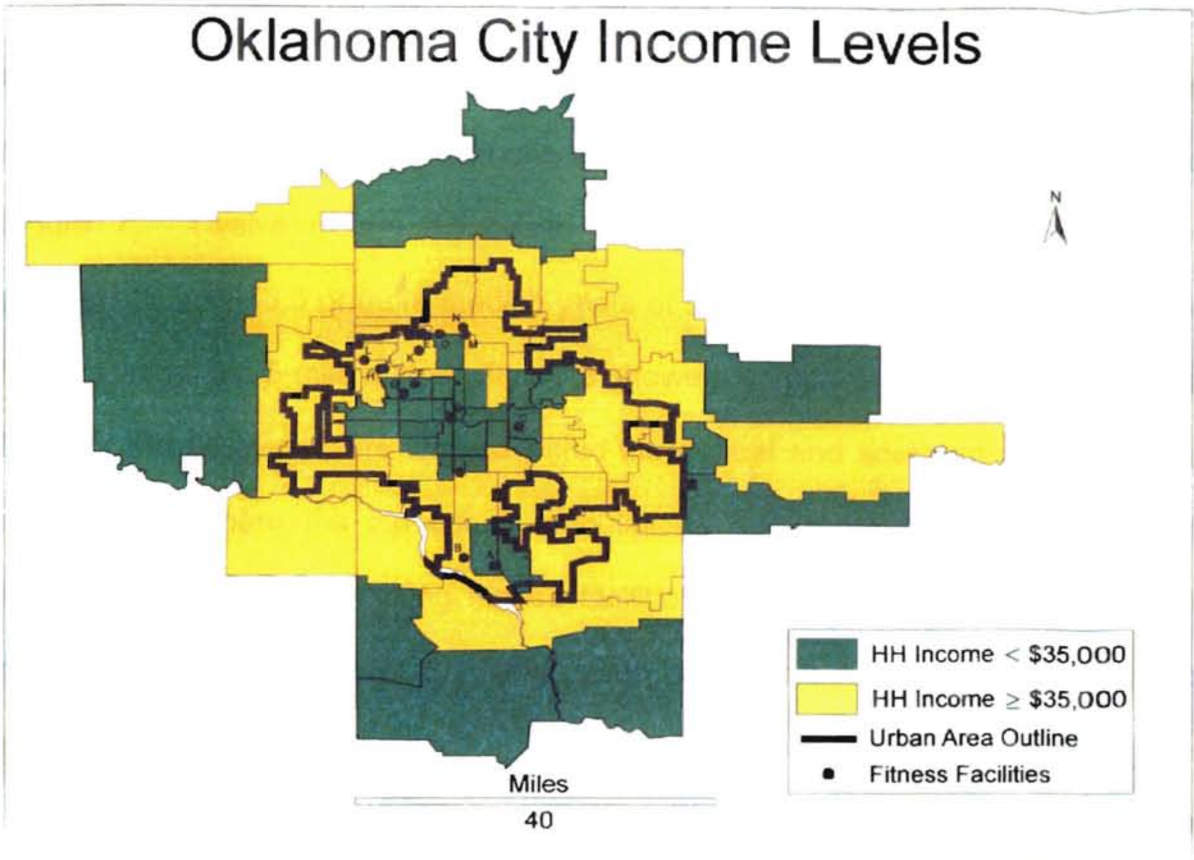

Figure 5. Distribution of Income Levels Within Oklahoma City Study Area

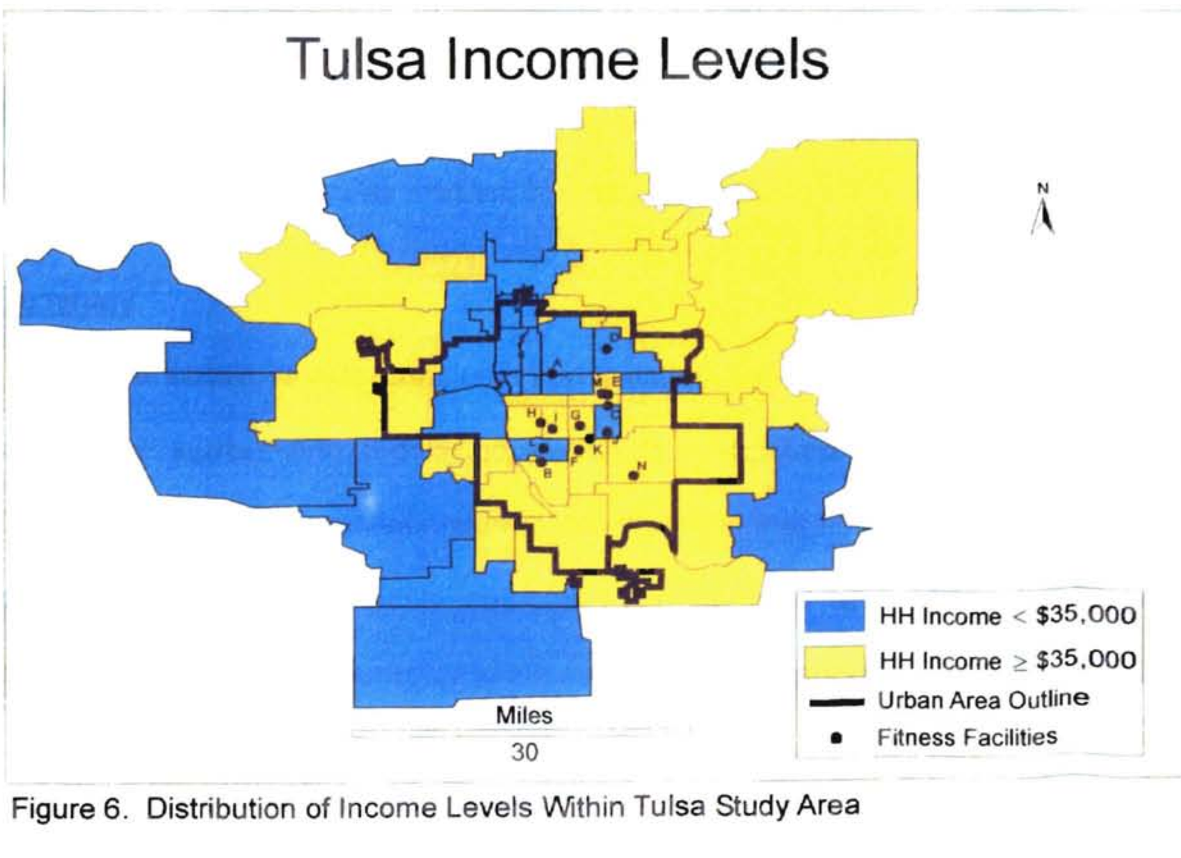

Figure 6. Distribution of Income Levels Within Tulsa Study Area

Analysis pertaining to years of schooling concluded that there were high concentrations in the northern and southern regions of the Oklahoma City study area of populations having at least one-and-a-half years of college, as illustrated in Figure 7. Twelve of the 15 health clubs resided in zip codes containing populations with 13.5 or more median years of schooling, with the remaining three located within the 5-mile buffer. Figure 8 shows a comparable scenario for Tulsa. Eight of the 14 gyms were located within the central and southern portion of the urban area, where the zip code's populations had more than 13.5 years of schooling. The six remaining fitness facilities were positioned within a 5-mile proximity to this section of the urban area containing higher median years of schooling.

Similar results existed in both study areas for the white collar/blue collar and single/married variable examinations. Excluding two instances, every 5-mile area surrounding each gym had a 1/1 ratio for single to married people. Concerning occupational status, however, there was a greater proportion of white-collar workers to blue-collar workers in every example.

Summary

The above results conclude that existing fitness facilities are positioned where the surrounding 5-mile population is comprised of the target market. Demographics of the populations meet most criteria that fitness businesses use to pinpoint where their potential customers are located and where health club businesses have the opportunity to succeed. The next section answers whether

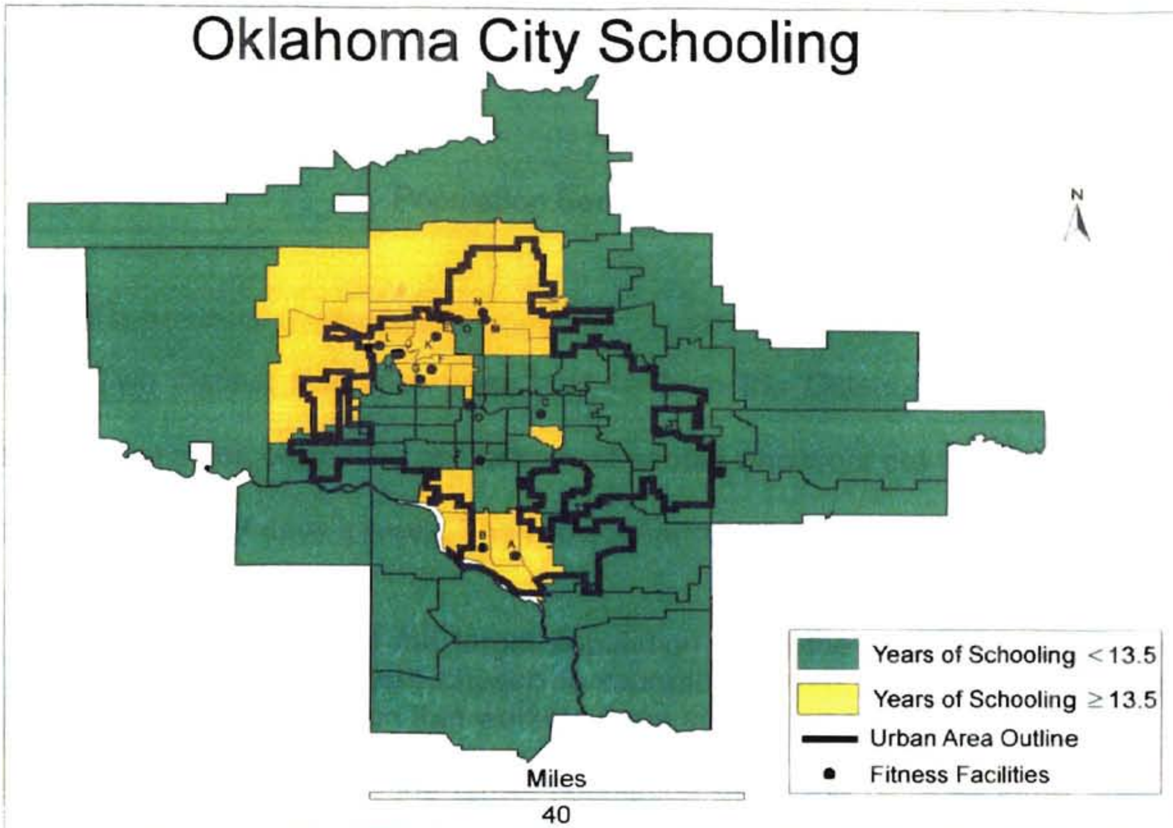

Figure 7. Distribution of Years of Schooling within Oklahoma City Study Area

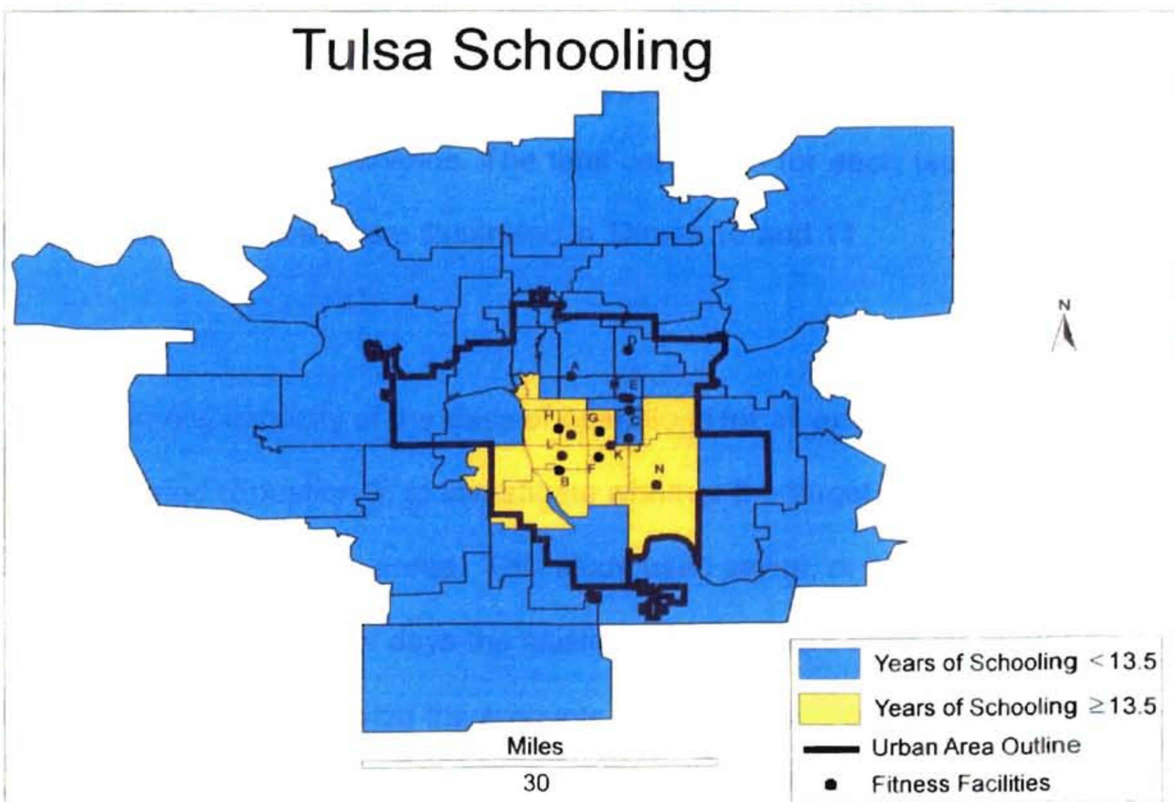

Figure 8. Distribution of Years of Schooling within Tulsa Study Area

the target populations surrounding each facility were under-served in terms of exercise service provision.

Population Service Analysis

Analysis

Two distinct scenarios were built for both the Oklahoma City and Tulsa studies that incorporated the percentage of people who work out at a health club a certain number of days a week. The two scenarios constructed were:

> Scenario 1: 12% of the target population using the facilities three times a week. This level was chosen to represent actual percentages of people throughout the nation that workout three times a week.
>
> Scenario 2: 30% of the target population using the facilities three times a week. This was a hypothetical case, chosen at the author's discretion, to represent an anticipated percentage of people who use the gym.

Tables 8 and 9 summarize the number of potential fitness participants (Equation 1) for every gym in both scenarios. The total capacities for each facility in one week of operation (Equation 2) are illustrated in Tables 10 and 11.

Results

Carrying capacity of the days of operations for all existing fitness facilities was calculated (Equation 3) to investigate whether the target populations were underserved for the study areas. This study used seven, or one full week's worth, to represent the number of days the existing facilities were open for operation. Tables 12 and 13 summarize the amounts of underserved people for each study area.

TABLE 8

NUMBER OF POTENTIAL FITNESS PARTICIPANTS: OKLAHOMA CITY

Gym	12% - 3x/Week	30% - 3x/Week
1. Bodies By Ray Inc.	14,928	37,321
2. The Health Club	16,793	41,981
3. TLC Fitness Center	16,501	41,252
4. Mid-America Athletic Club	28,788	71,969
5. Pinnacle Fitness & Training	20,446	51,116
6. Pacer Fitness Center	27,928	69,820
7. Weight Room - 24 Hours	33,301	83,252
8. Cagle's USA Fitness Center	25,586	63,965
9. Cagle's Southern Athletic Club	20,150	50,376
10. All American Fitness Center	28,552	71,380
11. All American Fitness Center	27,000	67,500
12. Gold's Gym	26,076	65,191
13. Gold's Gym	18,837	47,092
14. Adams Course	17,530	43,826
15. The Athletic Club (TAC)	22,386	55,966

TABLE 9

NUMBER OF POTENTIAL FITNESS PARTICIPANTS: TULSA

Gym	12% - 3x/Week	30% - 3x/Week
1. Bear's Gym	20,854	52,135
2. Body By Michael	21,381	53,452
3. East Side Gym	31,232	78,080
4. Healthwell	13,257	33,143
5. Mikey's Gym and Health Food	28,674	71,685
6. Physical Edge	29,734	74,336
7. Planet Fitness	36,020	90,050
8. Tulsa Athletic Club (TAC II)	33,694	84,235
9. Tulsa Athletic Club (TAC I)	32,644	81,611
10. Gold's Gym	30,798	76,995
11. Bally Total Fitness	34,086	85,215
12. All American Fitness Center	29,366	73,415
13. All American Fitness Center	28,674	71,685
14. All American Fitness Center	17,014	42,534

TABLE 10

CAPACITY FOR ONE WEEK OF OPERATION: OKLAHOMA CITY

Gym	One Week Capacity
1. Bodies By Ray Inc.	8,526
2. The Health Club	27,930
3. TLC Fitness Center	9,555
4. Mid-America Athletic Club	5,145
5. Pinnacle Fitness & Training	13,818
6. Pacer Fitness Center	11,760
7. Weight Room - 24 Hours	14,700
8. Cagle's USA Fitness Center	13,230
9. Cagle's Southern Athletic Club	14,700
10. All American Fitness Center	27,195
11. All American Fitness Center	21,070
12. Gold's Gym	14,700
13. Gold's Gym	18,963
14. Adams Course	38,220
15. The Athletic Club (TAC)	44,100

TABLE 11

CAPACITY FOR ONE WEEK OF OPERATION: TULSA

Gym	One Week Capacity
1. Bear's Gym	8,820
2. Body By Michael	8,820
3. East Side Gym	5,880
4. Healthwell	9,702
5. Mikey's Gym and Health Food	11,760
6. Physical Edge	9,555
7. Planet Fitness	14,700
8. Tulsa Athletic Club (TAC II)	11,760
9. Tulsa Athletic Club (TAC I)	5,145
10. Gold's Gym	10,290
11. Bally Total Fitness	14,700
12. All American Fitness Center	15,680
13. All American Fitness Center	15,435
14. All American Fitness Center	21,364

TABLE 12

UNDERSERVED POPULATIONS: OKLAHOMA CITY

Gym	12% - 3x/Week	30% - 3x/Week
1. Bodies By Ray Inc.	6,402	28,795
2. The Health Club	N/A*	14,051
3. TLC Fitness Center	6,946	31,697
4. Mid-America Athletic Club	23,643	66,824
5. Pinnacle Fitness & Training	6,628	37,298
6. Pacer Fitness Center	16,168	58,060
7. Weight Room - 24 Hours	18,601	68,552
8. Cagle's USA Fitness Center	12,356	50,735
9. Cagle's Southern Athletic Club	5,450	35,676
10. All American Fitness Center	1,357	44,185
11. All American Fitness Center	5,930	46,430
12. Gold's Gym	11,376	50,491
13. Gold's Gym	N/A*	28,129
14. Adams Course	N/A*	5,606
15. The Athletic Club (TAC)	N/A*	11,866

* N/A = Not underserved

TABLE 13

UNDERSERVED POPULATIONS: TULSA

Gym	12% - 3x/Week	30% - 3x/Week
1. Bear's Gym	12,034	43,315
2. Body By Michael	12,561	44,632
3. East Side Gym	25,352	72,200
4. Healthwell	3,555	23,441
5. Mikey's Gym and Health Food	16,914	59,925
6. Physical Edge	20,179	64,781
7. Planet Fitness	21,320	75,350
8. Tulsa Athletic Club (TAC II)	21,934	72,475
9. Tulsa Athletic Club (TAC I)	27,499	76,466
10. Gold's Gym	20,508	66,705
11. Bally Total Fitness	19,386	70,515
12. All American Fitness Center	13,686	57,735
13. All American Fitness Center	13,239	56,250
14. All American Fitness Center	N/A*	21,170

* N/A = Not underserved

Figures 9 and 10 represent the amounts of underserved peoples for every gym in Scenario 1. Quantile classification used for the symbols ensured a distribution of the underserved population numbers. The maps illustrate a strong concentration of underserved people within the downtown area of Oklahoma City, and in the central part of the Tulsa urban area. Scenario 2 had similar results for each study area with the exception of higher portions of under-served people in every case, as shown in Figures 11 and 12.

Summary

The preceding analysis reveals that nearly all populations of the surrounding areas of existing health clubs are underserved in terms of available commercial fitness services. The first scenario, concerning the national average figure of 12% of the target market that utilize exercise facilities, has populations surrounding 4 gyms in Oklahoma City and one gym in Tulsa that are not under-served in terms of the provision of exercise services. However, examination of the second scenario, representing 30% of the target population, reveals an under-served population in every instance. These conclusions provide a framework for the final portion of the research: determining the best areal location of a new fitness facility in both urban boundaries.

Optimal Location Analysis

Analysis

The number of quadrats in the Oklahoma City and Tulsa study areas consisted of those that were contained within the 12-mile surrounding boundaries

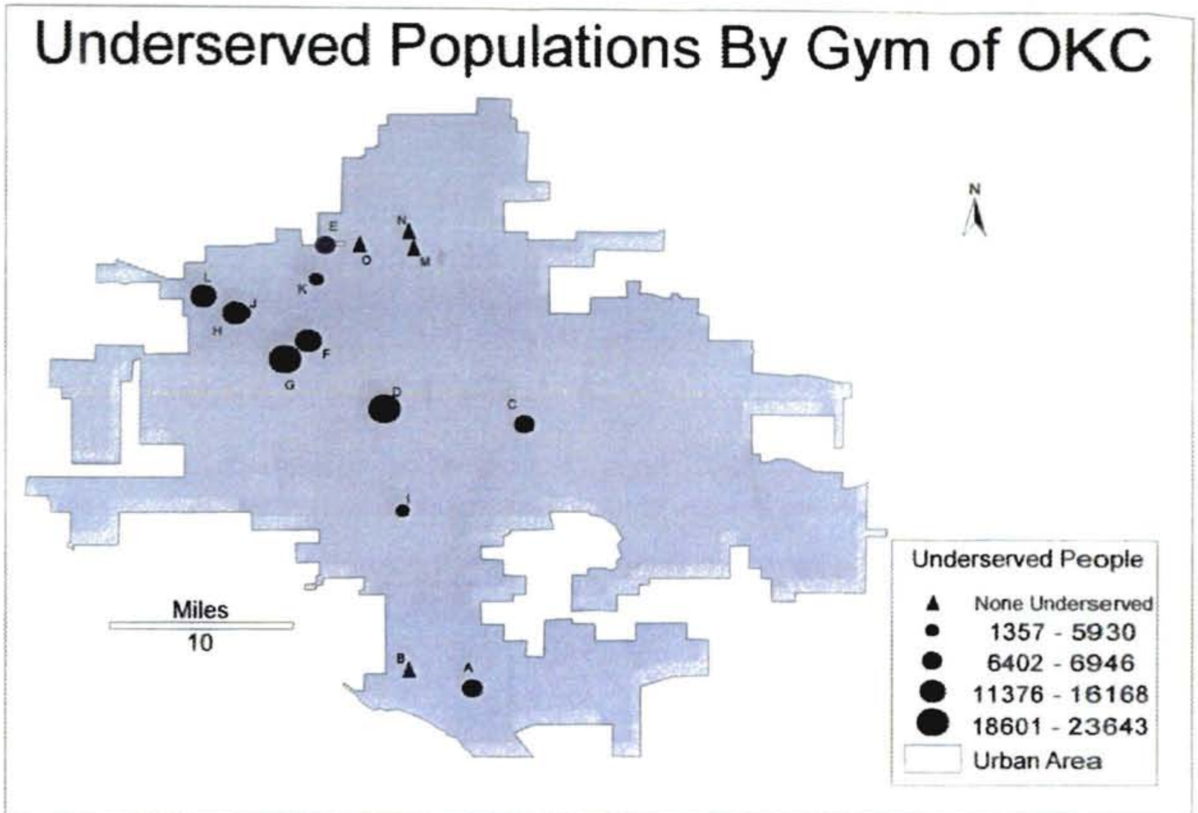

Figure 9. Numbers of Underserved People for Scenario 1: Oklahoma City

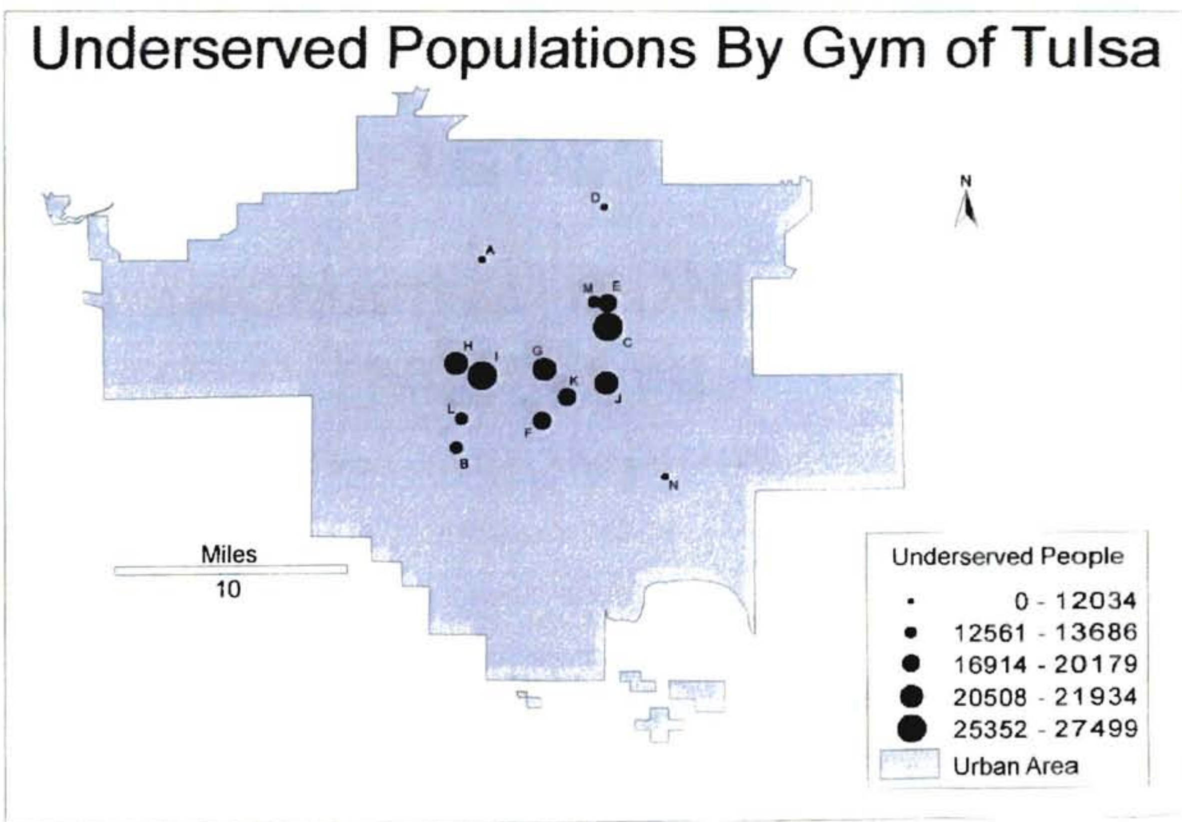

Figure 10. Numbers of Underserved People for Scenario 1: Tulsa

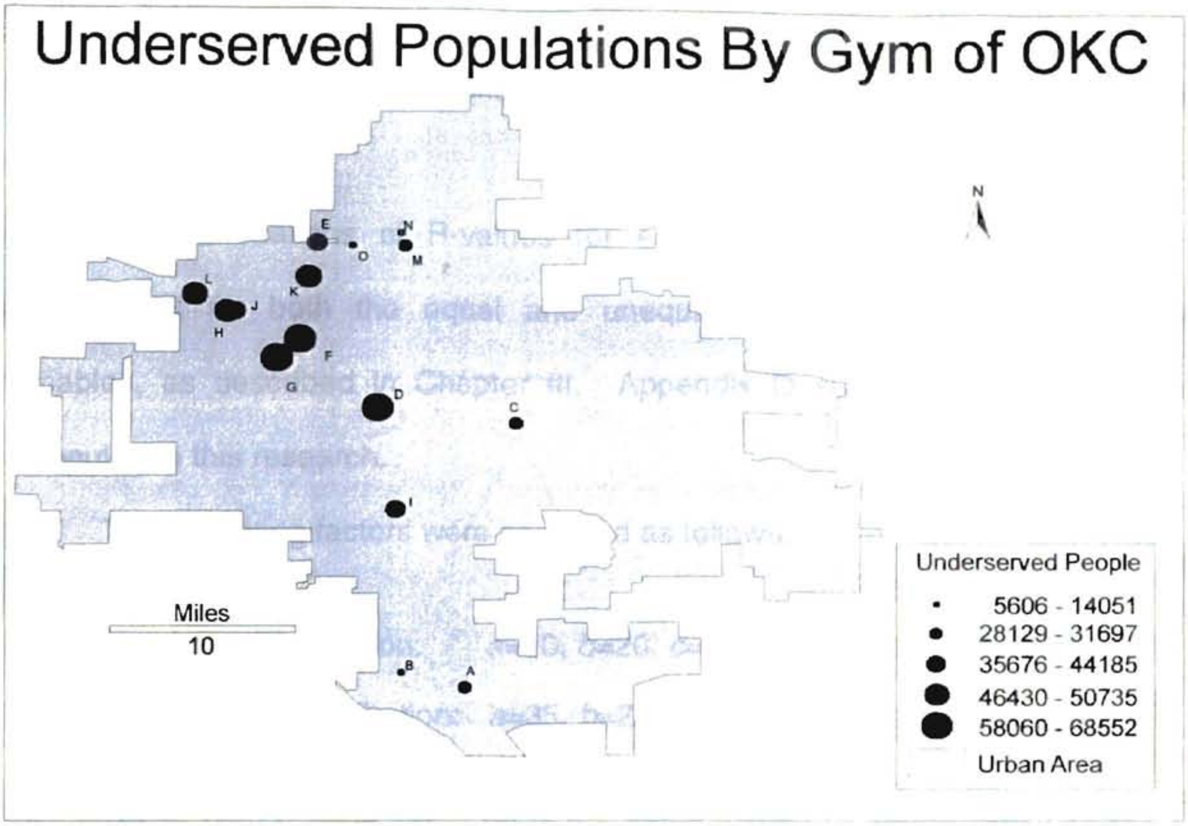

Figure 11. Numbers of Underserved People for Scenario 2: Oklahoma City

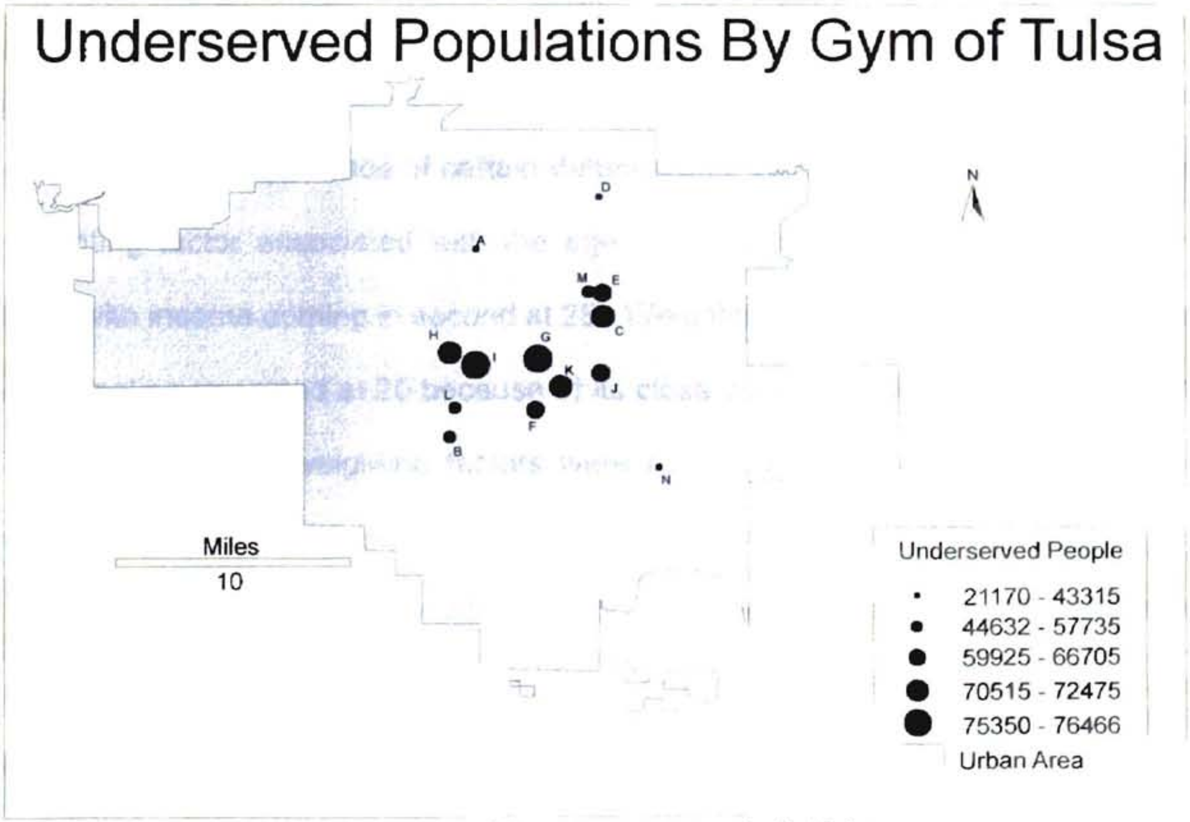

Figure 12. Numbers of Underserved People for Scenario 2: Tulsa

of each area. These came to 3,688 and 2,385 quadrats respectively. Each quadrat was assigned an identifier to be used as a reference for demographic analysis.

The summations of R-values for each zip code was computed in a spreadsheet for both the equal and unequal weighting distributions of the variables, as described in Chapter III. Appendix D summarizes the R-values computed in this research.

The weighting factors were assigned as follows:

Equal Weighting Distribution: a=20, b=20, c=20, d=20, e=20 $\Sigma = 100$

Unequal Weighting Distribution: a=35, b=25, c=20, d=10, e=10 $\Sigma = 100$

All weighting factors were set at 20 in the equal weighting classification to assure an equal distribution for each demographic variable's importance. The unequal weightings were selected at the author's discretion, based on prior research concerning the importance of certain demographic variables. In this instance, the weighting factor associated with the age variable was deemed most important (35), with income coming in second at 25. Weighting with regards to median years of schooling remained at 20 because of its close correlation to age. Occupational and marital status weighting factors were both reduced to 10 to represent the decrease in importance of the two variables in recent years (SGMA, 1999).

ArcView GIS mapping utilities were utilized to calculate distance and under-served figures for each quadrat in both scenarios. These values were then assigned using an ordinal scale as follows:

Distance:	0.0-2.5 miles = 1
	2.6-5.0 miles = 2
	5.1-7.5 miles = 3
	7.5-10.0 miles = 4
	> 10.0 miles = 5
Under-served People:	0-5,000 people = 1
	5,001-10,000 people = 2
	10,001-15,000 people = 3
	15,001-20,000 people = 4
	> 20,000 people = 5

Finally, the ArcView GIS database calculated the value for each quadrat (Equation 4), as described in Chapter III. Quadrat values for each study area are summarized in Appendix E. Examination of the most suitable areas for fitness facility placement was conducted by visual interpretation of chorplethic maps for Scenarios 1 and 2. Again, quantile classification was used to analyze quadrat values for the purpose of assuring distribution of the examined variables.

Results

Within the research, the higher the quadrat value, the more desirable the area for facility placement. Figures 13 and 14 illustrate the final quadrat values for the equal weightings of Scenario 1. The Oklahoma City analysis exposed a small area within the Western portion of the urbanized designation that was most desirable for the location of a new facility. Likewise, examination of Tulsa revealed an approximately 4x6-mile area in the Western part of the urban designation, and a 1x2-mile section in the central portion of area that were suitable for the location of new exercise centers. Analysis of the unequal weightings of Scenario 1 for both study areas revealed almost exact results, as illustrated in Figures 15 and 16.

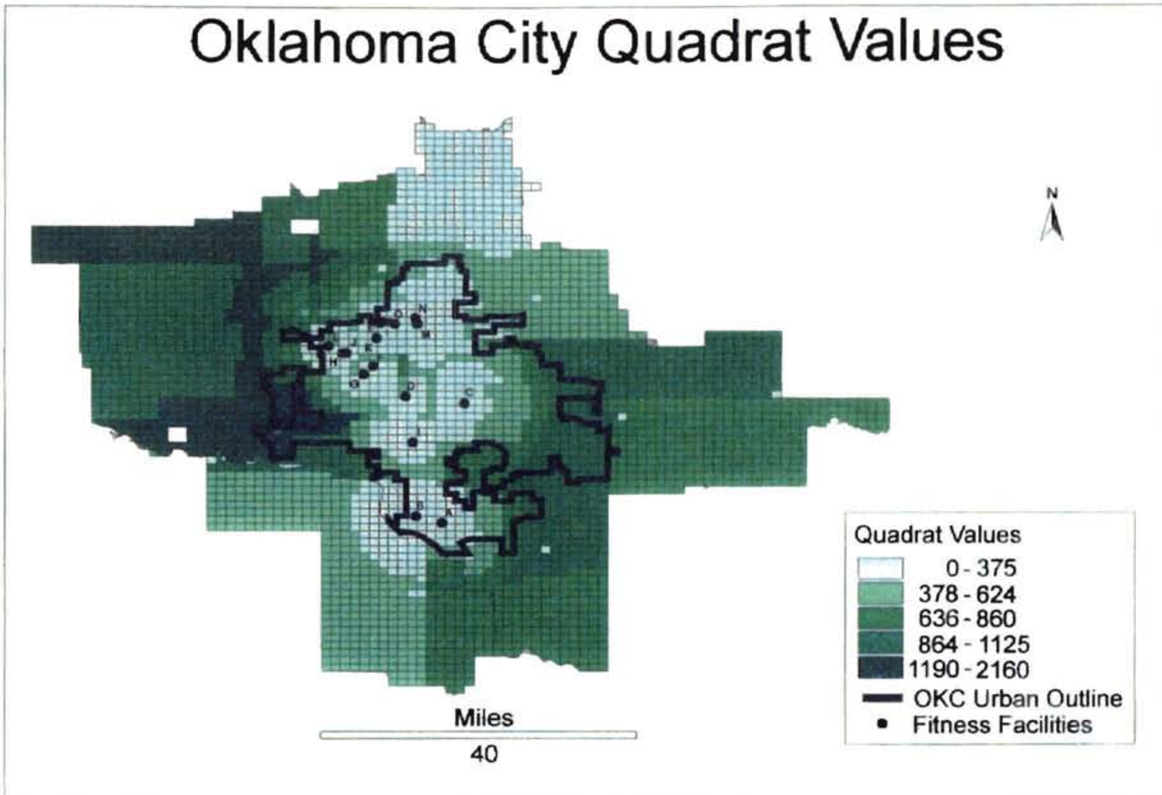

Figure 13. Final Quadrat Values For Scenario 1 With Equal Weighting Distributions: Oklahoma City

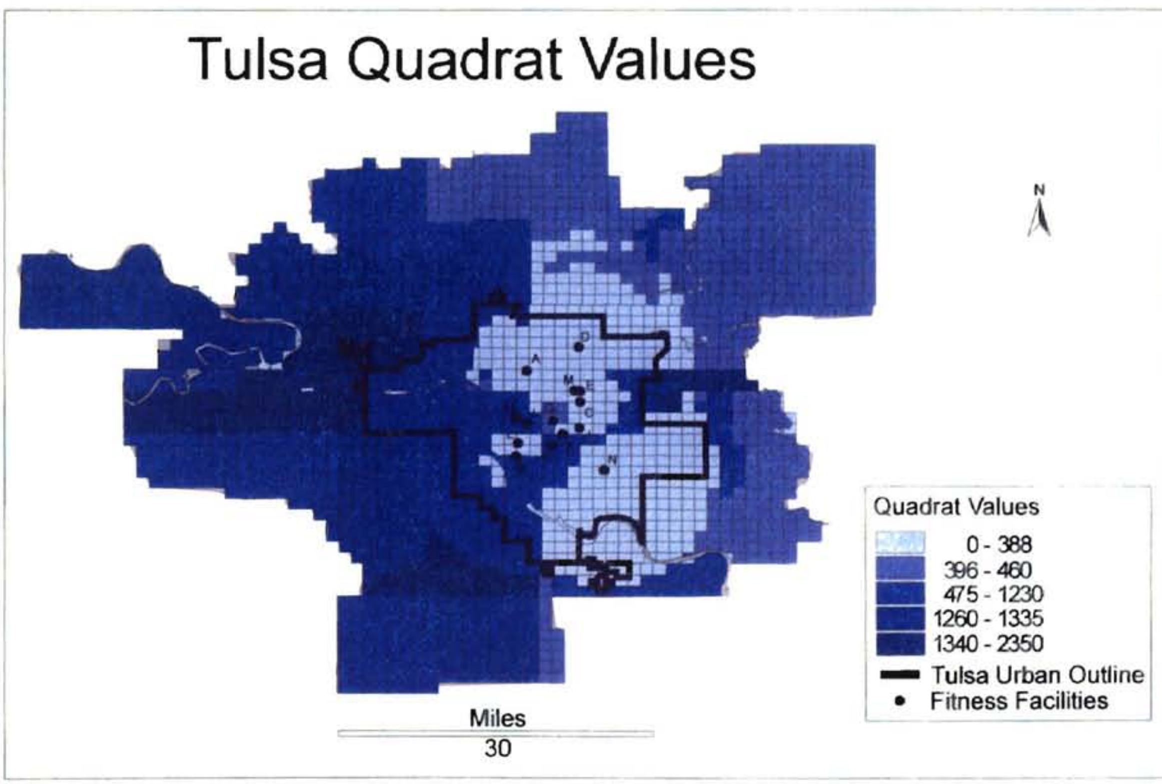

Figure 14. Final Quadrat Values For Scenario 1 With Equal Weighting Distributions: Tulsa

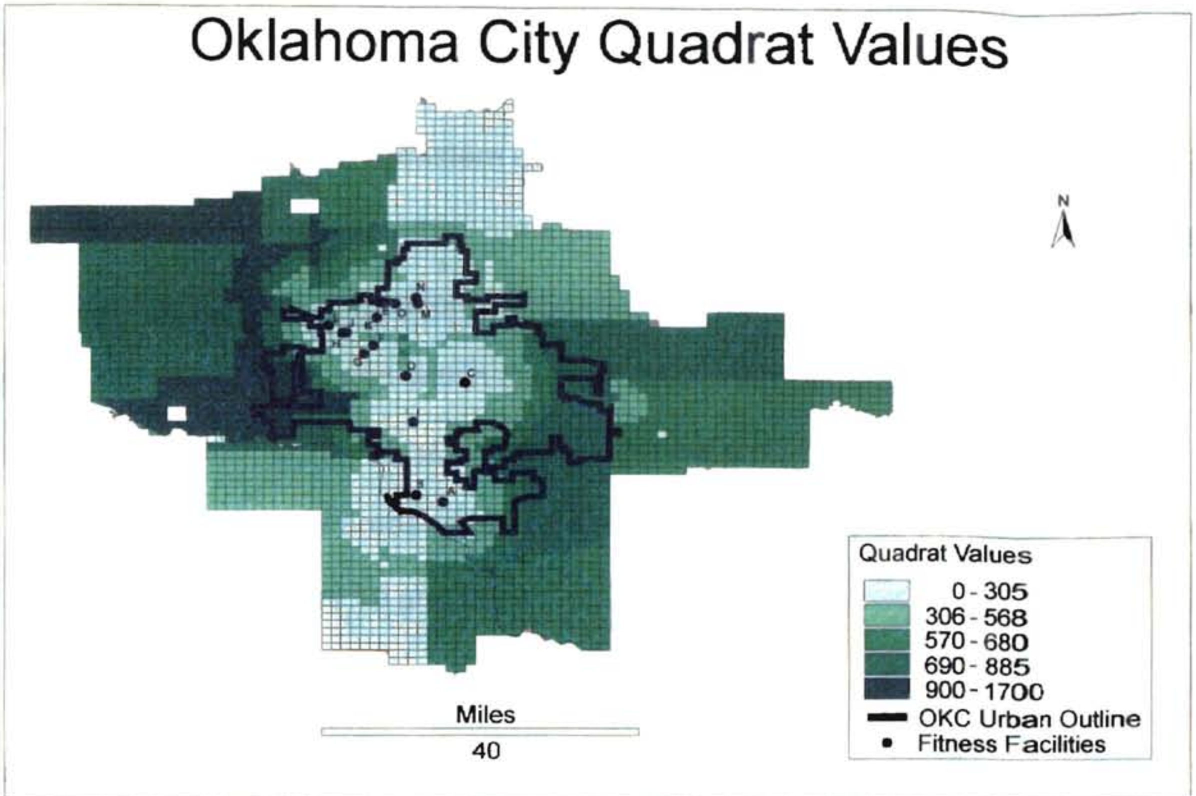

Figure 15. Final Quadrat Values For Scenario 1 With Unequal Weighting Distribtutions: Oklahoma City

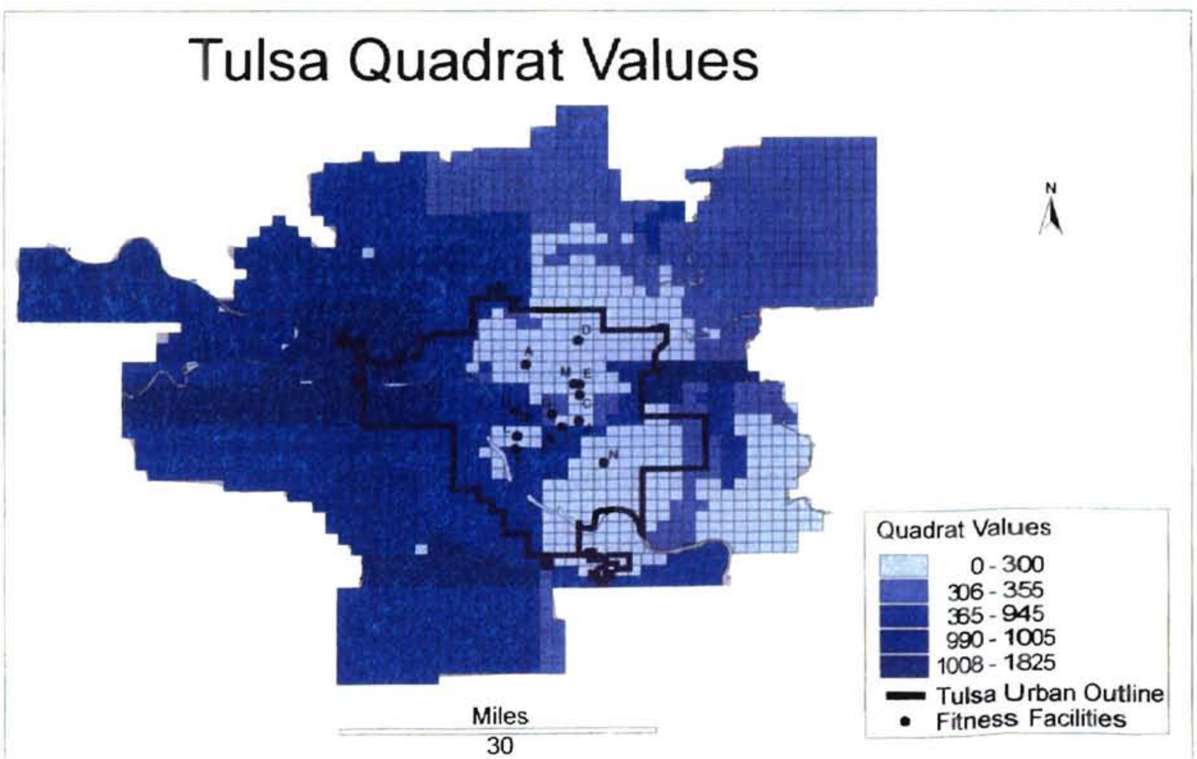

Figure 16. Final Quadrat Values For Scenario 1 With Unequal Weighting Distribtutions: Tulsa

Analysis of the equal weighting distributions of Scenario 2 within the Oklahoma City area showed two areas deemed suitable for facility placement. These were located in the eastern outskirts of the urban designation, and again in the Western portion of the urban area, as shown in Figure 17. Figure 18 illustrates the equal weighting distributions of Scenario 2 within the Tulsa urban area. An approximate 3x6-mile area within the western portion of Tulsa was most desirable for a new fitness facility. Again, the unequal weighting distributions of Scenario 2 concerning both study areas revealed almost exact results as the equal weighted, as illustrated in Figures 19 and 20.

Summary

The preceding section found the locations most desirable for the placement of new fitness facilities for equal and unequal weighting distributions of the demographic variables in Scenarios 1 and 2. The eastern and western outskirts of the designated urban areas, as illustrated in the accompanying Figures, are the best areas for the placement of new exercise centers based on selected demographic variable, underserved populations, and distance.

Conclusion

This chapter discusses the overall analyses and results of the study concerning (1) locations of existing facilities, (2) numbers of underserved or overserved peoples, and (3) the optimal areal location for new fitness facilities in the two study areas. Chapter V provides a brief outline of the separate examinations of the research, followed by final conclusions recommendations

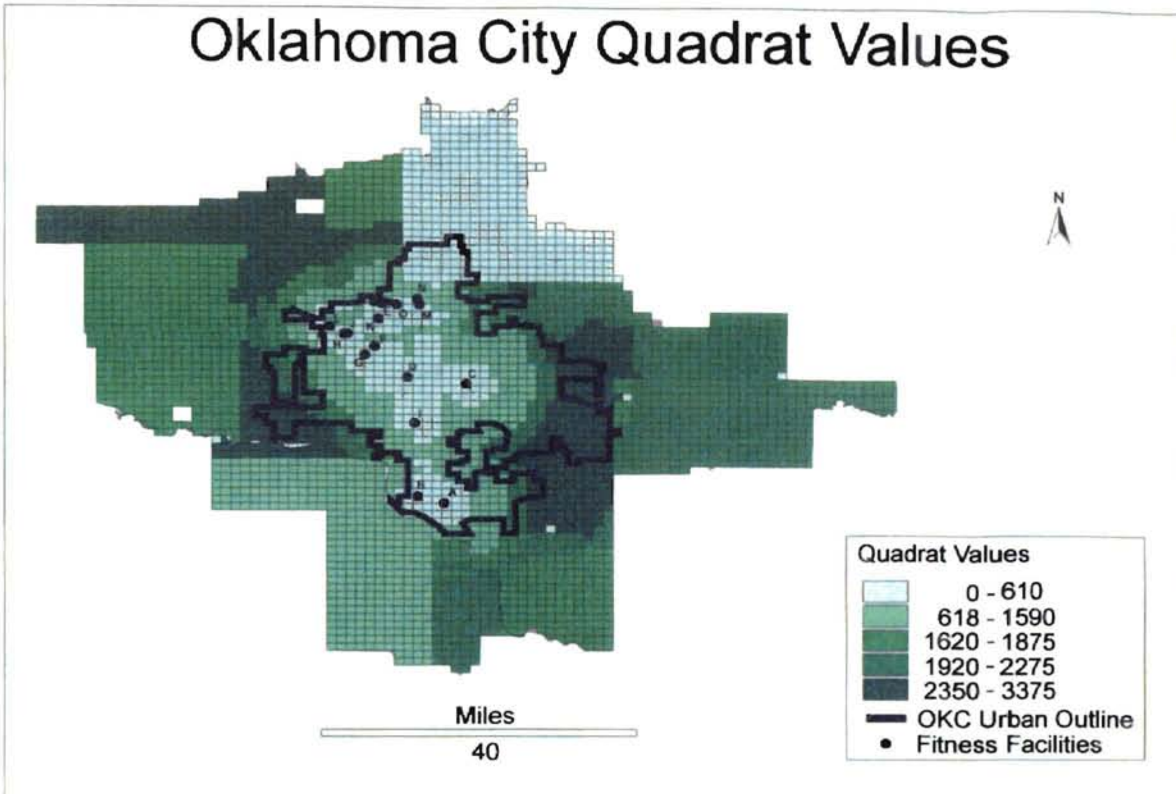

Figure 17. Final Quadrat Values For Scenario 2 With Equal Weighting Distribtutions: Oklahoma City

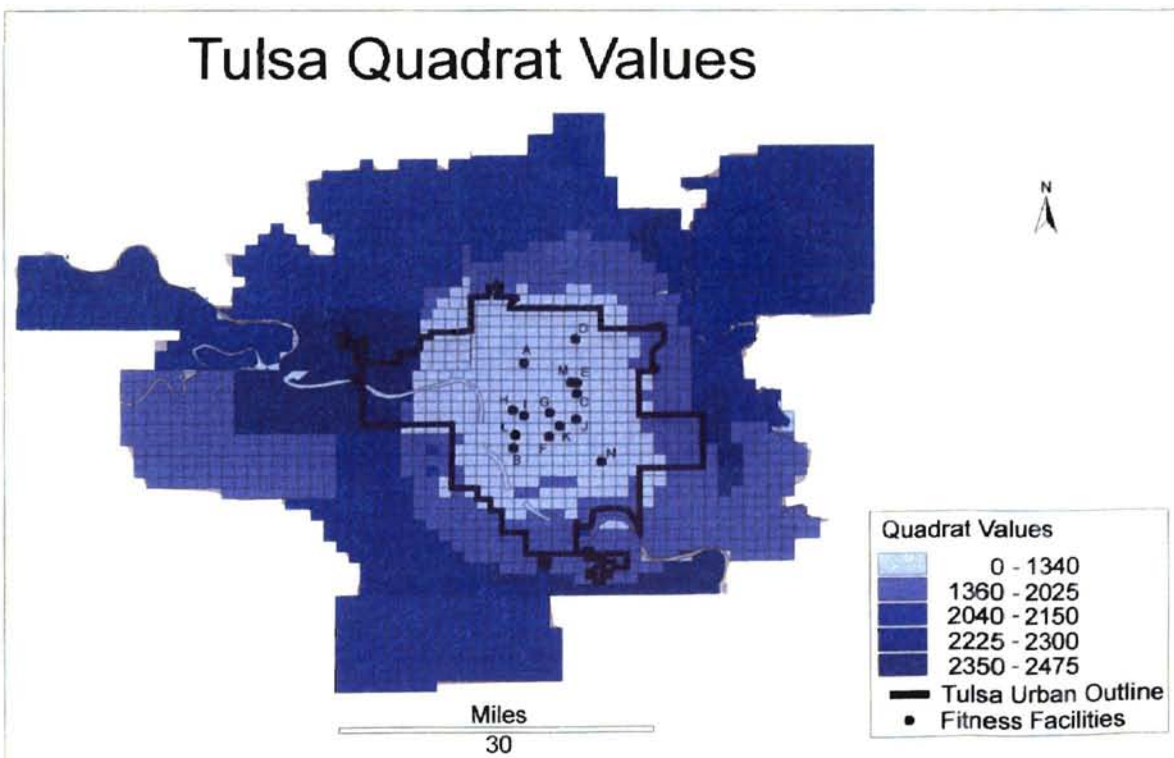

Figure 18. Final Quadrat Values For Scenario 2 With Equal Weighting Distribtutions: Tulsa

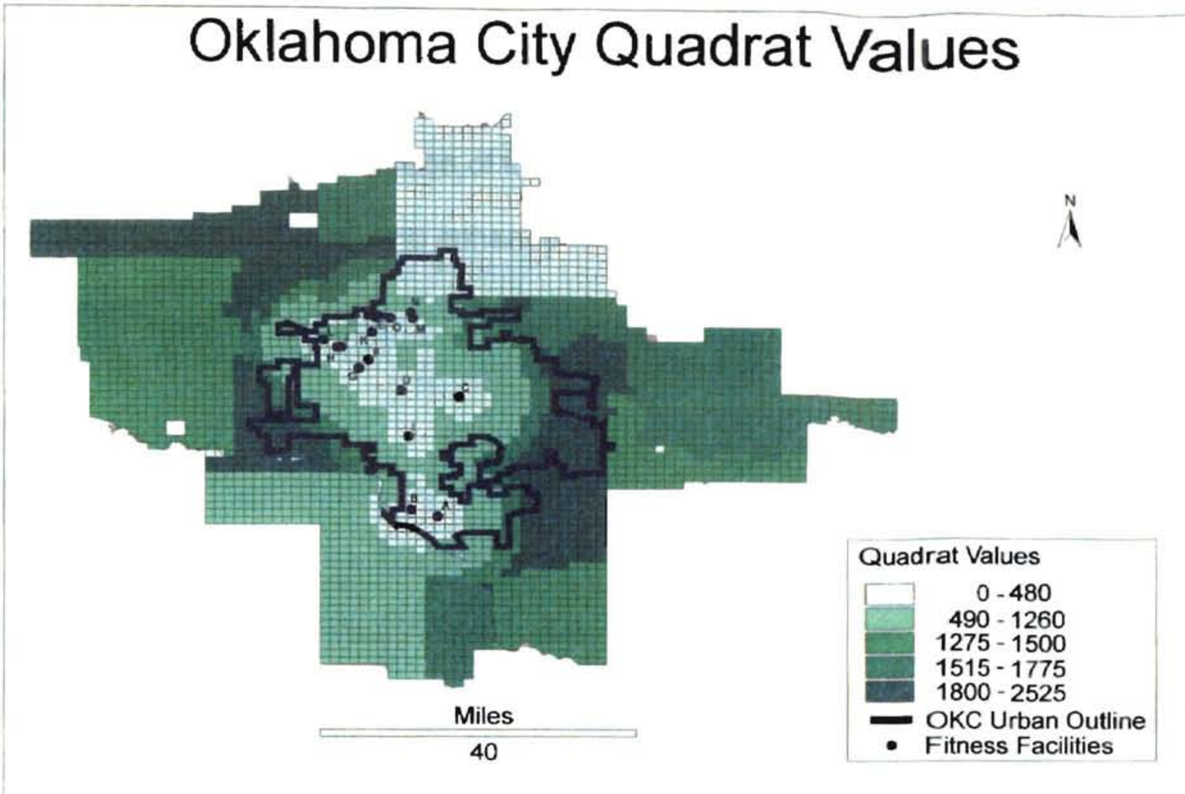

Figure 19. Final Quadrat Values For Scenario 2 With Unequal Weighting Distribtutions: Oklahoma City

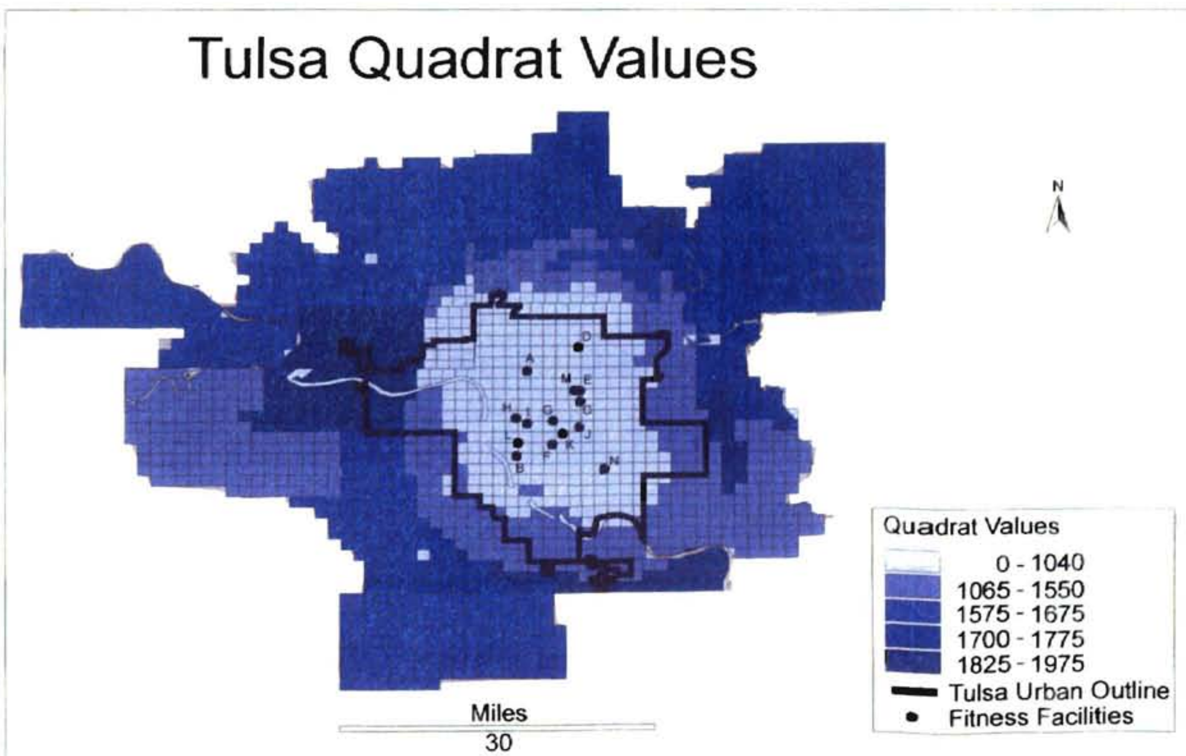

Figure 20. Final Quadrat Values For Scenario 2 With Unequal Weighting Distribtutions: Tulsa

concerning the optimal location of new fitness centers within Oklahoma City and Tulsa. The chapter also addresses some limitations associated with the study, and concludes with a discussion of future research that can further support the significance of this thesis, and enhance future examination of fitness facility placement.

CHAPTER V

SUMMARY OF RESEARCH

Objectives and Analyses

The purpose of this study was to discover the optimal location of a new fitness facility in both the Oklahoma City and Tulsa urban areas to better serve potential health club participants within the target market. Specific research questions included:

1. Do surrounding populations within 5 miles of existing fitness centers represent the fitness industry's target market?
2. Is each facility's surrounding populace underserved or overserved in terms of fitness services provided by the commercial gym?
3. What is the optimal areal location of a new fitness facility within each study area based on underserved population numbers, present locations of health clubs, and demographic data that support its existence?

Initial demographic analysis within the surrounding 5 miles of existing fitness facilities investigated whether the populations represented the target market. This was to examine whether the populations of both study areas consisted of enough of the fitness industry's target market to justify the placement of a new fitness facility. Age, income, education, occupational status, and marital status were all analyzed to examine where populations having the most favorable demographic characteristics were located within the urban areas of the two cities.

Two distinct scenarios were built for both the Oklahoma City and Tulsa studies that incorporated the percentage of people who work out at a health club a certain number of days a week. The two cases for each study area applied (1) actual percentages of people that workout three times a week, and (2) anticipated percentages of people who exercise the standard amount of three times a week. This was to represent actual population numbers using gym facilities, and to analyze hypothetical models of possible health club participants.

Exercise service provided to the population in both study areas was analyzed to justify the need for additional fitness services. This was completed by calculating the number of underserved or overserved people within the surrounding 5-mile buffer, with respect to fitness service provision. This assumed that people within the industry's target market were willing to pay for fitness services from a commercial fitness facility.

Finally, the study areas were divided into one by one-mile quadrats, and an algorithm calculated values for each quadrat using underserved populations, distance, and demographic variable ratios. The ratios were affected by an equal and unequal weighting classification, selected at the author's discretion and from past research signifying the importance of the demographic variables used in this study. These values were then grouped and displayed on maps created in the ArcView GIS software package to illustrate the optimal locations for new fitness facilities.

Conclusions

The results of analyzing the market areas for existing fitness facilities concluded that the gyms were positioned where the surrounding 5-mile population was comprised of the target demographic group. Demographics of the populations met most criteria that fitness businesses use when pinpointing where their potential customers are located and where health club businesses have the opportunity to succeed.

Analysis concerning fitness service provision revealed that nearly all populations of the surrounding areas of existing health clubs were underserved in terms of available commercial fitness services in the first scenario. Populations surrounding 4 gyms in Oklahoma City and one gym in Tulsa were not under-served in terms of the provision of exercise services in the first scenario. However, the second scenario showed an underserved population in every case. This justified the need for additional exercise services and facilities in the two cities.

The final analysis of the research discovered the optimal locations for the placement of new fitness facilities for equal and unequal weighting distributions of the demographic variables in both scenarios. Figures 21, 22, 23, and 24 illustrate the optimal locations of new fitness facilities for Scenario 1. The results concerning the most desirable locations for Scenario 2 are portrayed in Figures 25, 26, 27, and 28. These destinations were based on amounts of underserved populations, distance from existing fitness facilities, and demographic characteristics of the target market that justify the existence of an exercise center.

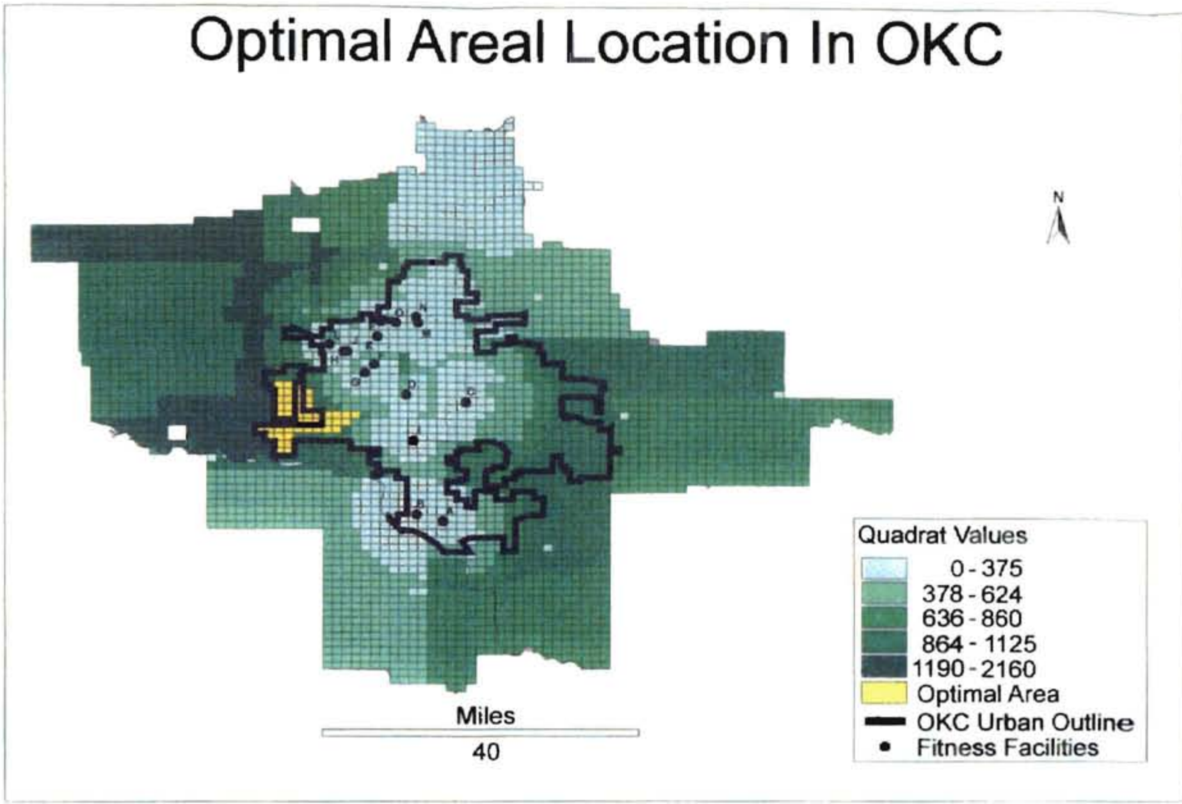

Figure 21. Optimal Areal Locations For Scenario 1 With Equal Weighting Distributions: Oklahoma City

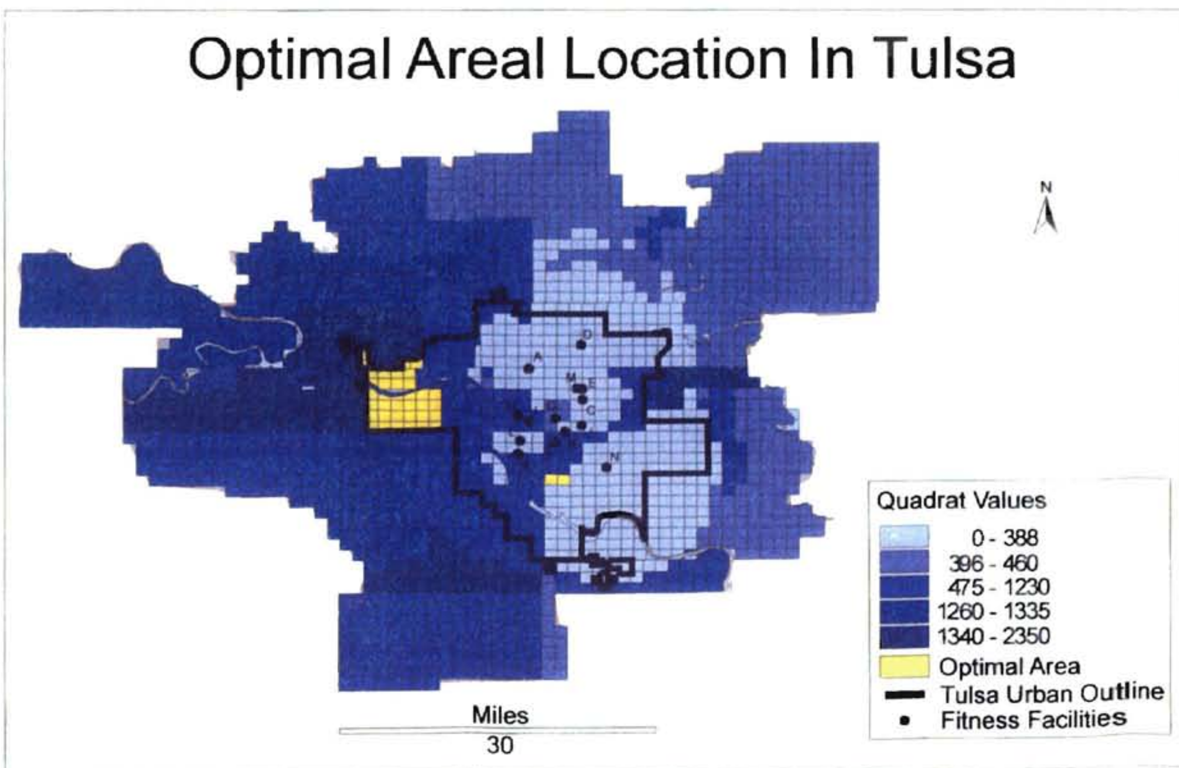

Figure 22. Optimal Areal Locations For Scenario 1 With Equal Weighting Distributions: Tulsa

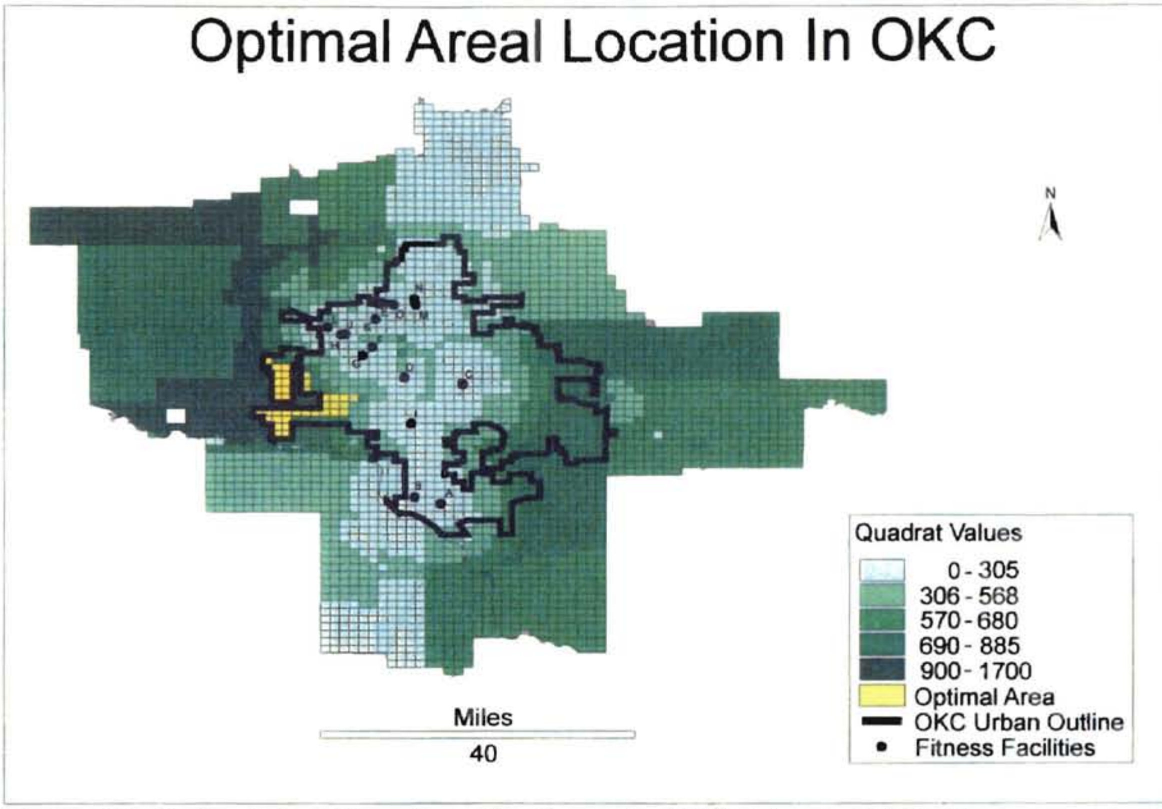

Figure 23. Optimal Areal Locations For Scenario 1 With Unequal Weighting Distributions: Oklahoma City

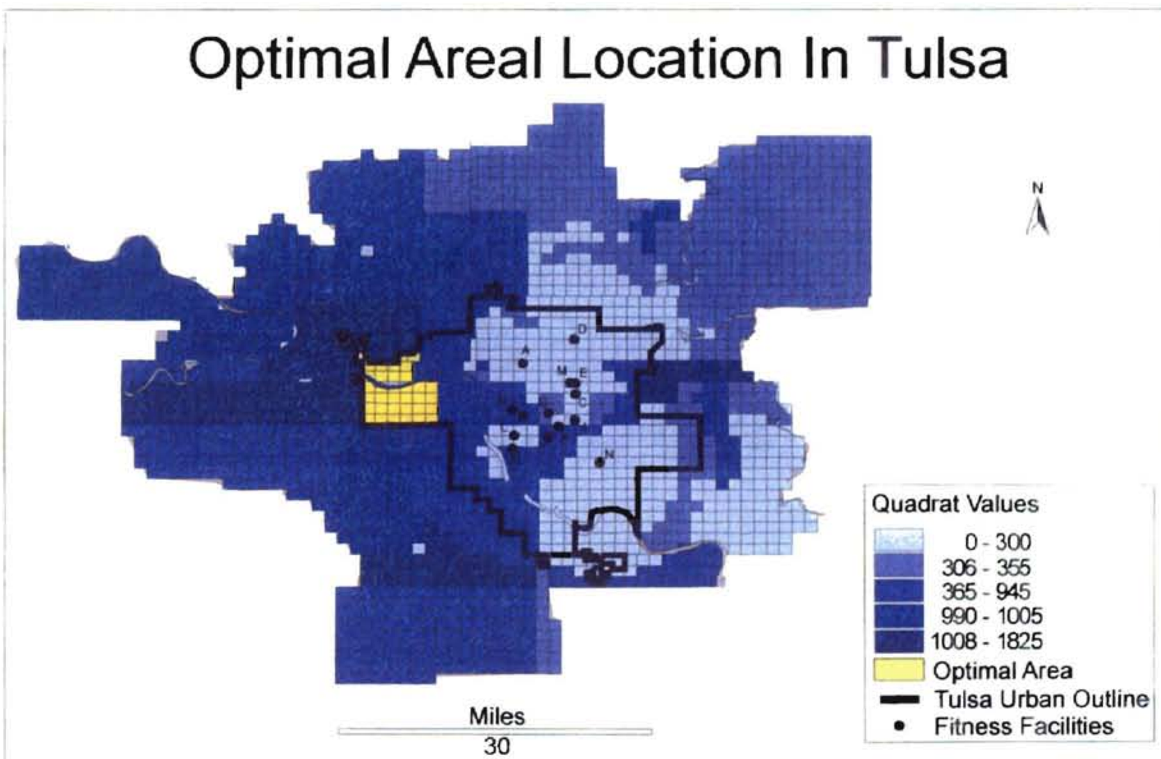

Figure 24. Optimal Areal Locations For Scenario 1 With Unequal Weighting Distributions: Tulsa

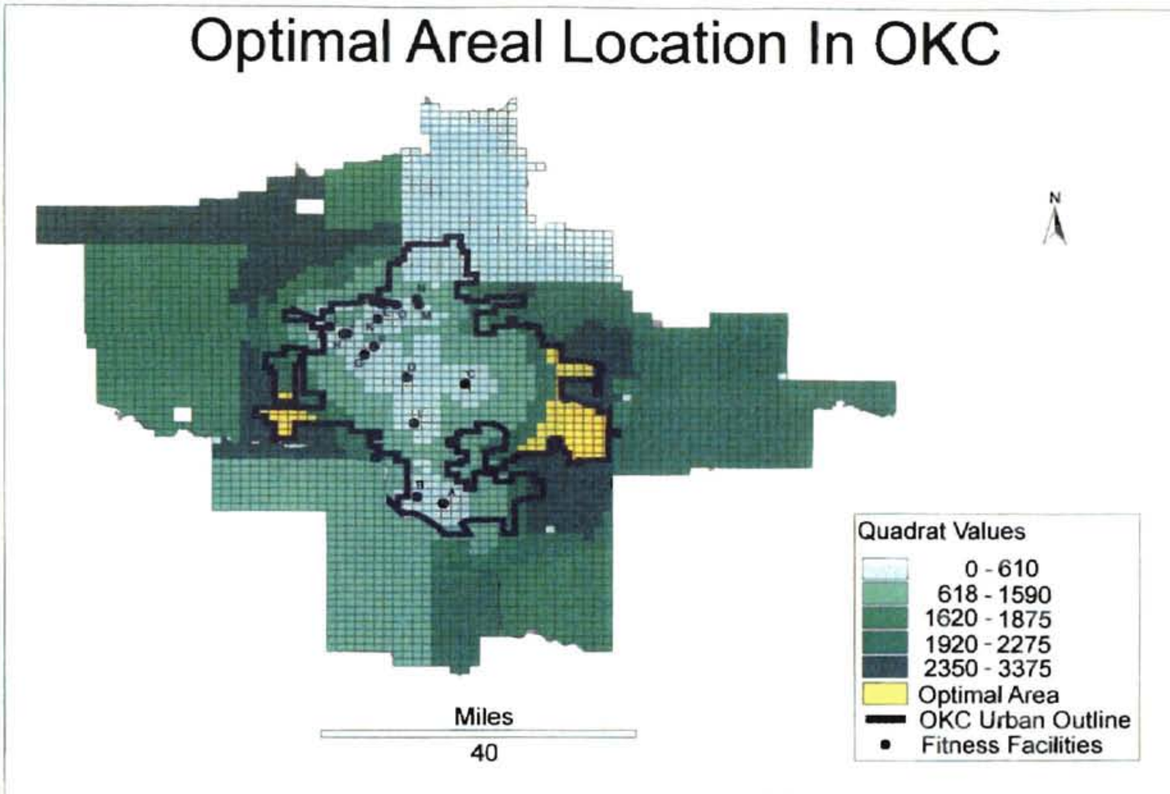

Figure 25. Optimal Areal Locations For Scenario 2 With Equal Weighting Distributions: Oklahoma City

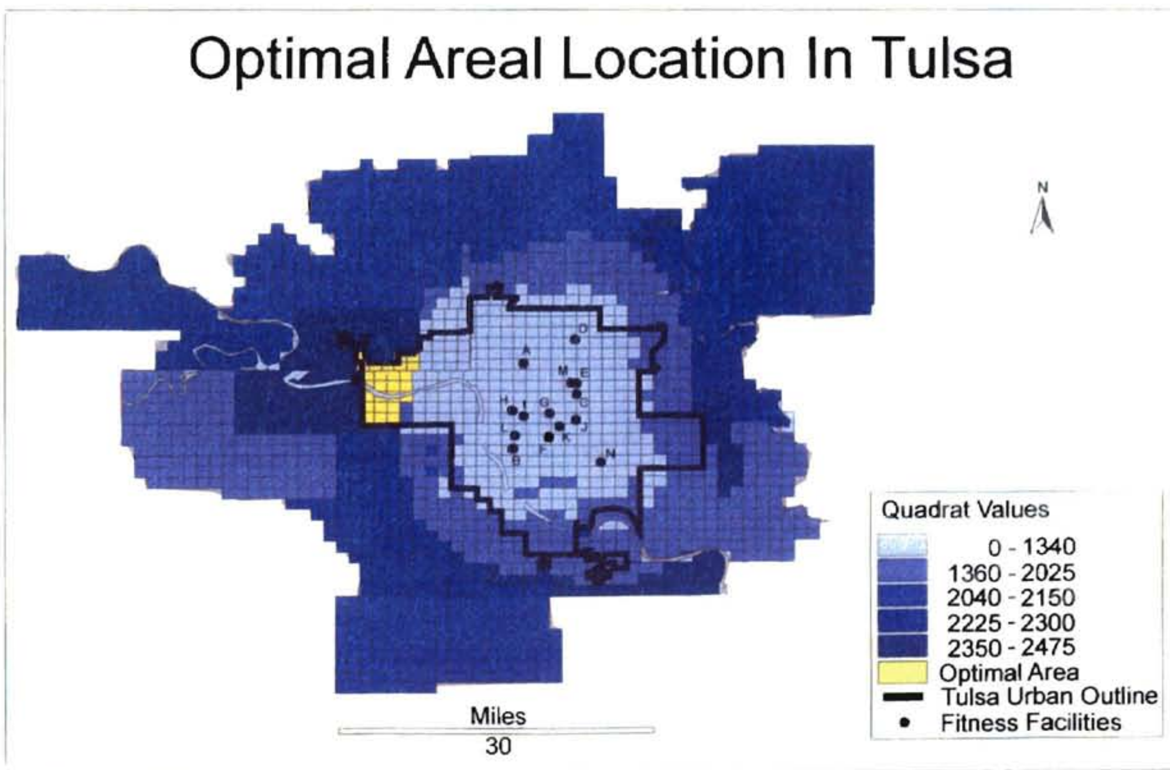

Figure 26. Optimal Areal Locations For Scenario 2 With Equal Weighting Distributions: Tulsa

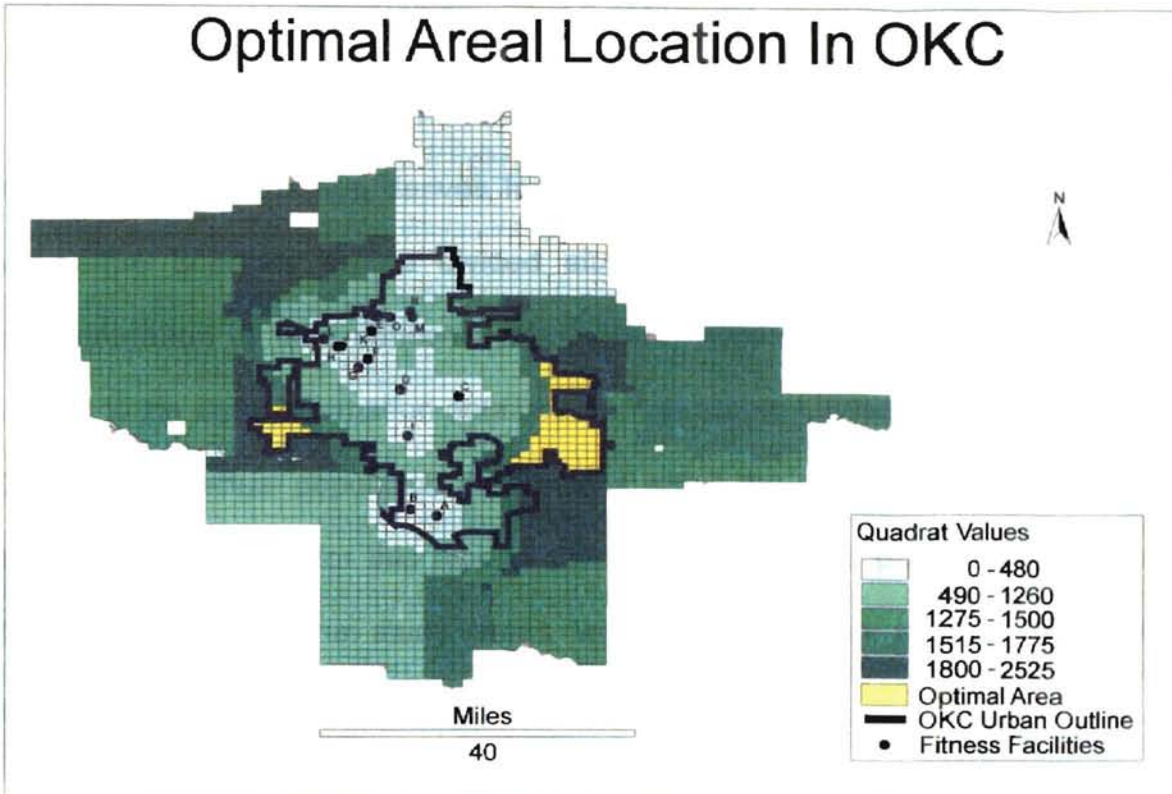

Figure 27. Optimal Areal Locations For Scenario 2 With Unequal Weighting Distributions: Oklahoma City

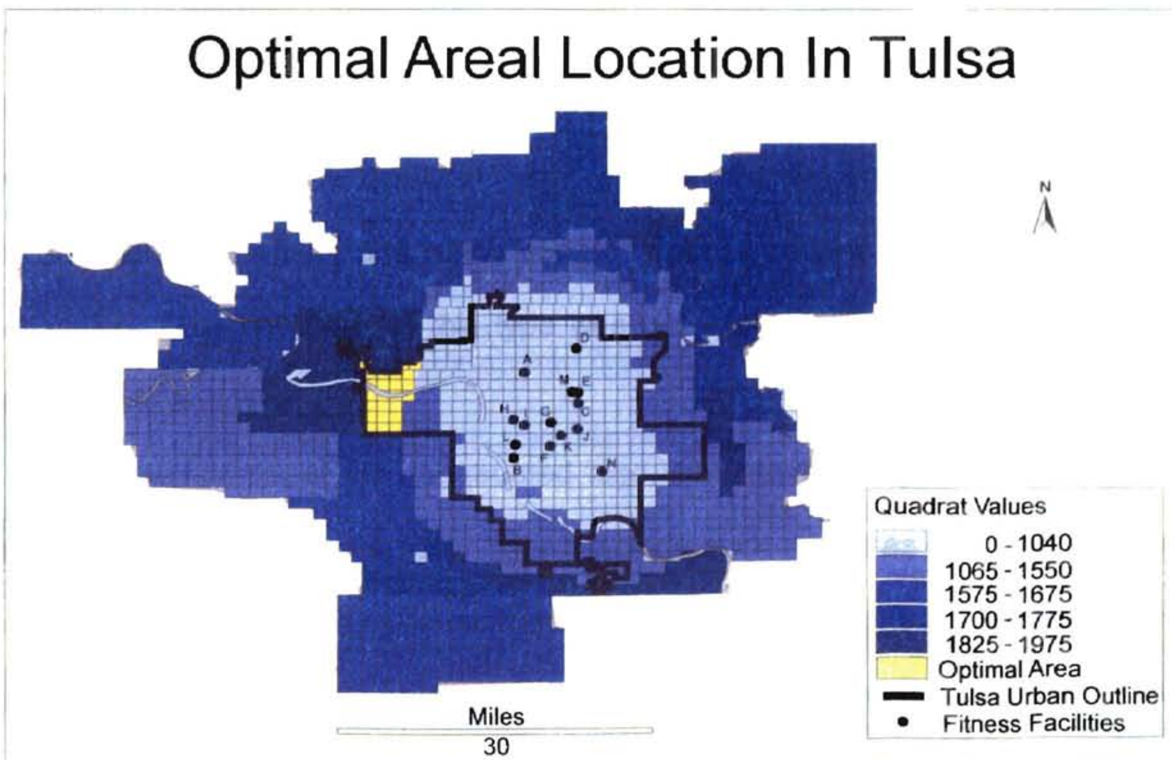

Figure 28. Optimal Areal Locations For Scenario 2 With Unequal Weighting Distributions: Tulsa

Recommendations and Future Research

Being a generalized model, there are a few different limitations to the research. One limitation derives from assuming an even distribution of people within the quadrats of the divided study areas. Problems occur with the disaggregation of data concerning population numbers, and this research was limited to zip code information obtained from available United States census data. Collection of actual population distributions within the divisional units would have been more accurate for this type of investigation, so that proportions of people located throughout the study areas would be assigned to their appropriate designations.

Another limitation of the research deals with the assumption that those people within the target market want to use commercial fitness facilities to use exercise services, and will pay for those services. Formal surveys could be utilized to gather information on such things as what portion of the target market would actually want to exercise, what portion of the target market would use fitness center services, and which people might buy home fitness equipment for exercise. Data collection of this type was not implemented because of financial constraints and time.

Assumptions of the constructed algorithm provide a generalization of the factors involved with the model. These include such things as no transport costs, uncapacitated facilities, no investment constraints, and no technical constraints. Future studies can incoporporate all of these factors to conduct a much more elaborate study that accounts for each of these stipulations to decide where the optimal location for new fitness facilities would be.

Future studies involving the optimal location of fitness facilities can also use the procedures utilized in this research to analyze any number of different fitness services available to the public. These could include previously mentioned single-purpose activities like jazzercise, kickboxing, the increasingly popular "Tai Bo" workout, and yoga training.

Regarding characteristics of the target market, this research focuses its studies on the most prevalent demographic variables findings throughout the past decade. More recent investigations, however, have shown that increased participation of baby-boomers and senior citizens in the fitness industry is now beginning to drive the commercial market, as well as an increase in "women only" fitness facilities (Grantham, et al., 1998). Future studies can use these findings to narrow the focus to a specific market when using demographic variables to assist in locating the optimal location of fitness facilities.

The conclusions associated with the optimal areal locations of fitness facilities in both study areas were limited to utilization of demographic information, distance, and underserved population figures. Future research can include a number of other factors involved with the placement of the gyms, including real-estate issues, zoning, crime rates, parking, traffic flow, and availability for expansion of existing exercise facilities.

The equal and unequal weighting distributions associated with the demographic variables utilized in this research can be modified to account for any adjustments in the characteristics of the target market that are deemed important. This is essential when evaluating the importance of one demographic variable over another.

Finally, future studies involving the optimal location of fitness facilities can also enhance knowledge pertaining to the sub-discipline of sport geography. Additional research of fitness facility placement can add to the expanding role of exercise in American society, and illustrate possible shifts in the geographical spread of both recreational exercise and bodybuilding competition throughout the country. All of these recommendations for future research can add to the understanding of optimal location issues in economic geography, contribute to the study of the expanding role of sport and organized recreation within American society, and enhance the fitness industry's knowledge concerning the optimal location of fitness facilities and services.

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APPENDIX A

CHARACTERISTICS OF THE OKLAHOMA CITY AND TULSA STUDY AREAS

Study Area	Coverage (mi^2)	Population	Mean Med. HH Income	Med. Schooling
Entire 12-mile OKC area	8,360	304,893	$35,332	13.1 years
Entire 12-mile Tulsa Area	4,565	208,382	$38,751	13.3 years
OKC Urban Designation	1,890	90,435	$36,167	13.4 years
Tulsa Urban Designation	924	151,650	$40,265	13.7 years

APPENDIX B

LISTING OF SELECTED NATIONAL FITNESS CORPORATIONS

Gold's Gym Enterprises Inc.
358 hampton drive
Venice, CA 90291

Bally Total Fitness
PO Box 19111
Baltimore, MD 21284-2006

Bally Total Fitness
PO Box 2777
Huntington Beach, CA 92647-3003

Sporting Goods Manufacturers Association
200 Castlewood Drive
North Palm Beach, Fl 33418

Powerhouse Gyms International, Inc.
24385 Halsted Road, Suite 2000
Farmington Hils, MI 48335

APPENDIX C

CHARACTERISTICS OF FITNESS FACILITIES

CHARACTERISTICS OF FITNESS FACILITIES: OKLAHOMA CITY

Gym	Square Footage	Visibility*	Traffic*	Parking**	Capacity***	# people per day	# people per week
Bodies By Ray	7,800	3	3	40	87.0	1,218	8,526
The Health Club	21,000	3	3	100	285.0	3,990	27,930
TLC Fitness Center	10,000	2	3	50	97.5	1,365	9,555
Mid-America Athletic Club	4,100	1	3	10	52.5	735	5,145
Pinnacle Fitness and Training	18,000	3	3	200	141.0	1,974	13,818
Pacer Fitness Center	32,000	3	3	150	120.0	1,680	11,760
Weight Room - 24 hours	35,000	3	2	50	150.0	2,100	14,700
Cagle's USA Fitness Center	28,000	3	3	100	135.0	1,890	13,230
Cagle's Southern Athletic Club	40,000	3	3	100	150.0	2,100	14,700
All American Fitness Center	25,000	3	3	300	277.5	3,885	27,195
All American Fitness Center	25,000	3	3	200	215.0	3,010	21,070
Gold's Gym	12,000	3	3	100	150.0	2,100	14,700
Gold's Gym	15,000	3	3	45	193.5	2,709	18,963
Adam's Course	51,000	3	3	150	390.0	5,460	38,220
The Athletic Club (TAC)	33,000	3	3	150	450.0	6,300	44,100

* 1=low, 2=medium, 3=high

** # of spaces

*** # of stations

CHARACTERISTICS OF FITNESS FACILITIES: TULSA

GYM	Square Footage	Visibility*	Traffic*	Parking**	Capacity***	# people per day	# people per week
Bear's Gym	6,500	3	3	40	90	1,260	8,820
Body By Michael	8,000	1	3	50	90	1,260	8,820
East Side Gym	5,800	2	3	50	60	840	5,880
Healthwell	6,250	1	2	50	99	1,386	9,702
Mikey's Gym and Health Food	7,000	2	3	150	120	1,680	11,760
Physical Edge	5,000	2	3	80	98	1,365	9,555
Planet Fitness	21,000	3	3	150	150	2,100	14,700
Tulsa Athletic Club (TAC II)	29,000	1	2	150	120	1,680	11,760
Tulsa Athletic Club (TAC I)	40,000	3	3	200	53	735	5,145
Gold's Gym	15,000	3	3	75	105	1,470	10,290
Bally Total Fitness	25,000	3	2	150	150	2,100	14,700
All American Fitness Center	25,000	1	3	80	160	2,240	15,680
All American Fitness Center	25,000	1	2	80	158	2,205	15,435
All American Fitness Center	30,000	2	3	100	218	3,052	21,364

* 1=low, 2=medium, 3=high

** # of spaces

*** # of stations

APPENDIX D

SAMPLES OF CALCULATED R-VALUES

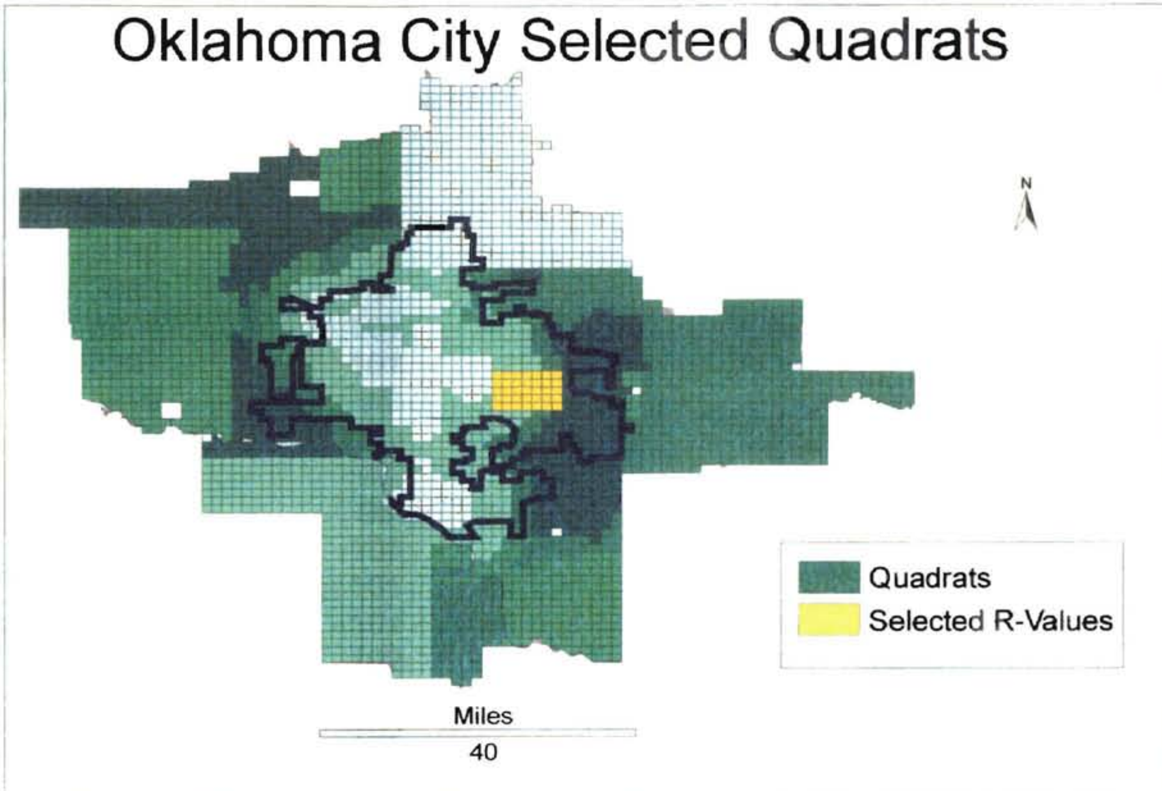

Figure 1. Selected Quadrats To Represent R-Values: Oklahoma City

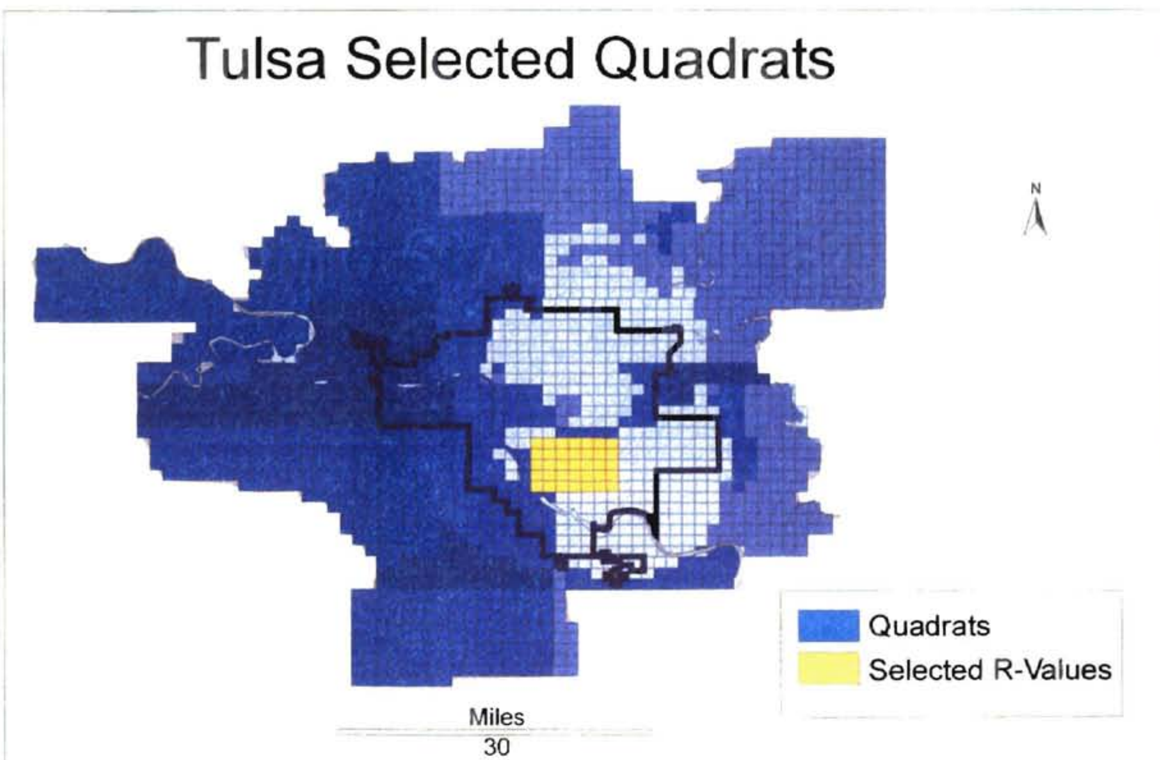

Figure 2. Selected Quadrats To Represent R-Values: Tulsa

Calculated R-Values For Equal Weighting of
Scenario 2: Oklahoma City (Selected Sample Quadrats)

Quadrat	R-Value
3389	96
3390	96
3391	96
3392	101
3393	101
3394	101
3395	101
3419	96
3420	96
3421	96
3422	96
3423	101
3424	101
3425	101
3449	102
3450	102
3451	102
3452	101
3453	101
3454	101
3455	101
3480	102
3481	102
3482	102
3483	101
3484	101
3485	101
3486	101
3511	102
3512	102
3513	102
3514	102
3515	102
3516	101
3517	101

Calculated R-Values For Equal Weighting of
Scenario 1: Tulsa (Selected Sample Quadrats)

Quadrat	R-Values
440	101
441	101
442	137
443	137
444	137
445	116
449	116
455	116
457	116
461	137
462	189
463	189
464	137
465	137
473	116
474	116
475	137
476	137
477	137
478	189
481	189
487	189
488	189
490	137
491	137
496	136
497	136
498	136
505	189
506	189
507	96
509	96
510	136
511	136
513	96

APPENDIX E

SAMPLES OF CALCULATED QUADRAT VALUES

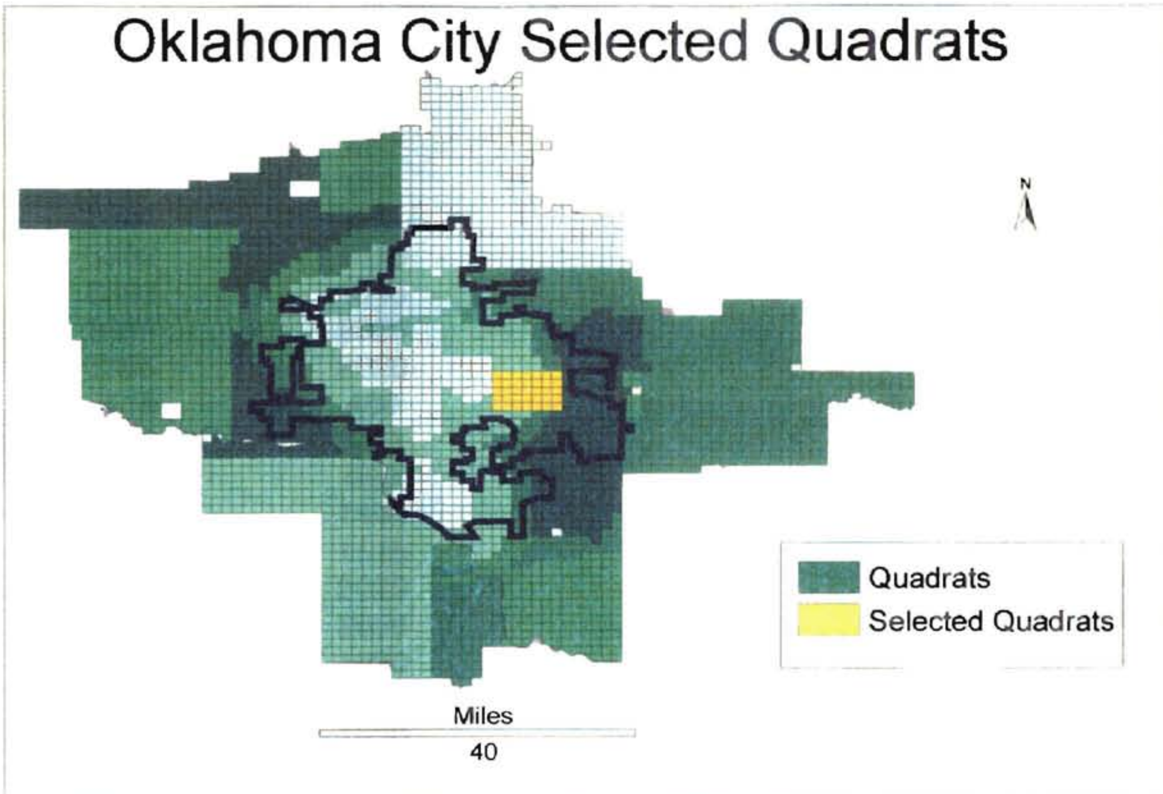

Figure 1. Selected Quadrats To Represent Quadrat Values: Oklahoma City

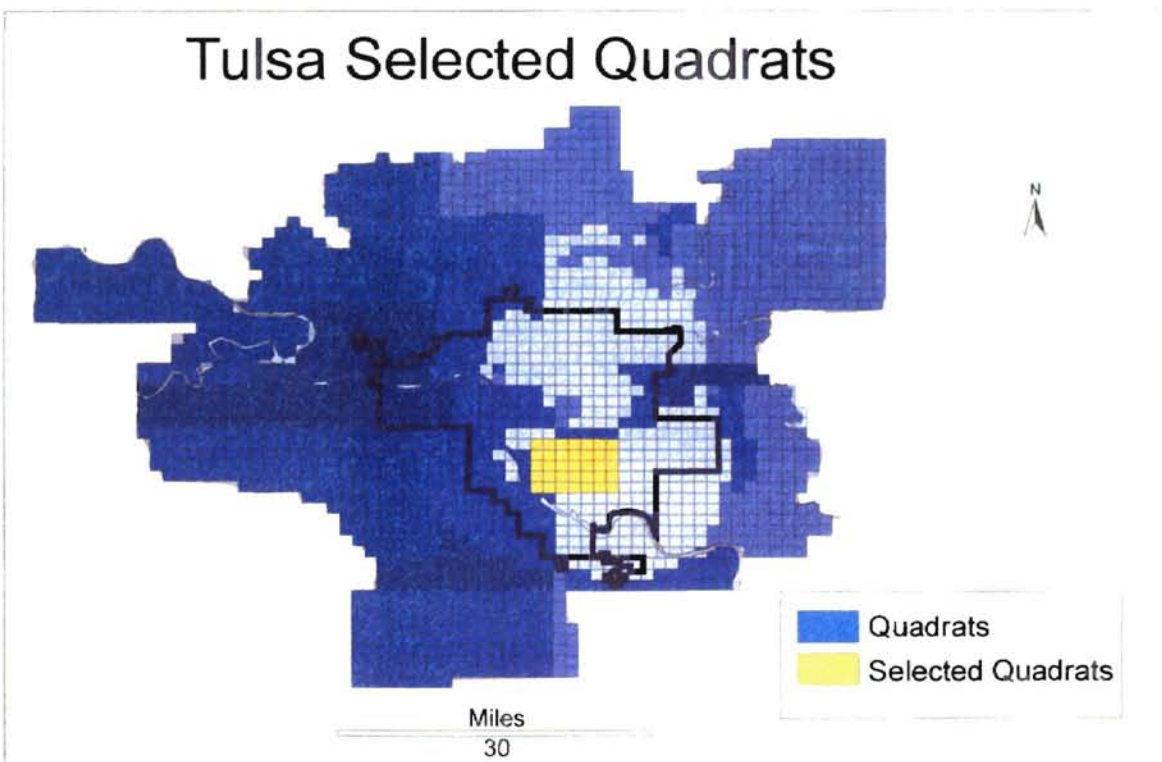

Figure 2. Selected Quadrats To Represent Quadrat Values: Tulsa

Calculated Quadrat Values For Equal Weighting of
Scenario 2: Oklahoma City (Selected Sample Quadrats)

Quadrat	Value
3389	480
3390	960
3391	960
3392	1515
3393	1515
3394	2020
3395	2020
3419	480
3420	960
3421	960
3422	1440
3423	1515
3424	2020
3425	2020
3449	1020
3450	1020
3451	1530
3452	1515
3453	1515
3454	2020
3455	2020
3480	1020
3481	1530
3482	1020
3483	1515
3484	2020
3485	2020
3486	2525
3511	1020
3512	1020
3513	1530
3514	1530
3515	2040
3516	2020
3517	2525

Calculated Quadrat Values For Equal Weighting of
Scenario 1: Tulsa (Selected Sample Quadrats)

Quadrat	Value
440	303
441	303
442	685
443	685
444	685
445	116
449	116
455	116
457	116
461	685
462	567
463	567
464	685
465	685
473	116
474	116
475	685
476	685
477	137
478	567
481	567
487	567
488	567
490	1370
491	1370
496	272
497	136
498	136
505	1134
506	1134
507	192
509	192
510	136
511	136
513	192

VITA

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Candidate for the Degree of

Master of Science

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