ESRI UC 2007

CHALLENGES IN STUDENT RECRUITMENT FOR EDUCATIONAL INSTITUTIONS: MATERIALS AND METHODS

Case Study of Clarion University of PA: Analysis of 2004-2005 School Year Data

Yasser M. Ayad

Abstract

Successful student recruitment efforts lead to higher enrollment in various programs. This helps the higher education institutions to sustain their resources and maintain high level of educational services throughout its wide variety of academic programs. This study proposes a method that involves the application of GIS in: first, better understanding the available body of student and school district data by means of inter-relating important variables such as the median household income and driving distances, and second, tracing recommendations for future recruitment efforts based on the observations and analysis results.

1. Introduction

1.1. Rationale

Successful student recruitment efforts lead to higher enrollment in various programs. This helps the University community to sustain its resources and maintain high level of educational services throughout its wide variety of academic programs. In order to reach and maintain an adequate level of such performance, many variables have to be understood. A marketing approach would be beneficial in studying those variables and their interrelationships. Variables can include school district data, such as the number of college-bound students in a specific year, SAT averages, and their proximity to Clarion University. Also, it can include Clarion University's enrollee data such as their home proximity to the University, their personal SAT scores, relative median household income, family size, and academic interest.

Many of those data can be statistically analyzed in order to reveal patterns of relationships and specific trends that might be used to improve the existing marketing strategies for student recruitment. Best of all, those statistics and supporting databases can be mapped in order to show the spatial distribution of the statistical and spatial analyses by means of Geographic Information Systems (GIS). Those are tools that were mainly used in studying environmental-related phenomenon but now their applications encompass a wide variety of functions and serve a gamut of industries such as utilities, space and facilities management, urban, rural and regional planning, local governments, oil and gas, education, marketing and market analysis, locational-based services (LBS), communication, and surveying just to name a few.

It is believed that GIS methods can help in better understanding the surrounding demographics and assist in spatially and statistically interrelating them. This study will concentrate in analyzing data for Pennsylvania for the 2004-2005 school year.

1.2. Objectives

This study proposes a method that involves the application of GIS in order to, first, better understand the available body of student and school district data by means of inter-relating important variables, and second to trace recommendations for future recruitment efforts based on the observations and analysis results. The main aims of this study are to assess the value of analyzing the available data using GIS tools. The following objectives are traced in order to assist in drawing future directions in tackling potential student recruitment target areas:

1. Characterize the body of enrolled students for the school year 2004-2005 in terms of their relative median household income obtained from census data and their home town location;
2. Characterize Pennsylvania school districts in terms of:
    - the relative median household income;
    - total number of college-bound students (SAT takers); and,
    - proximity to Clarion University.
3. Run a weighting model to identify potential school districts for future student recruitment; and,
4. Assess the 2004-2005 recruitment efforts in comparison with the model results.

2. Data Requirement

2.1. Data types

The main mapping unit adopted in the current study was defined in accordance to the target market: the school district. Although data at the school district level were considered, but student-level target market was also acknowledged for future analysis.

Two main data types were required in order to conduct this analysis: spatial and non-spatial data. Spatial (i.e. space-related) data are those that can be represented in the form of maps and have a geographic (graphical) component. In this respect, two spatial data were collected (Figure 1): school district boundaries and census block groups (Appendix A). The school district boundaries contained the corresponding name and ID of every school district in Pennsylvania while the census block groups contained the median household income data (*P053001*). Both spatial data were downloaded from the Pennsylvania Spatial Data Access (PASDA) website hosted at Pennsylvania State University (http://www.pasda.psu.edu).

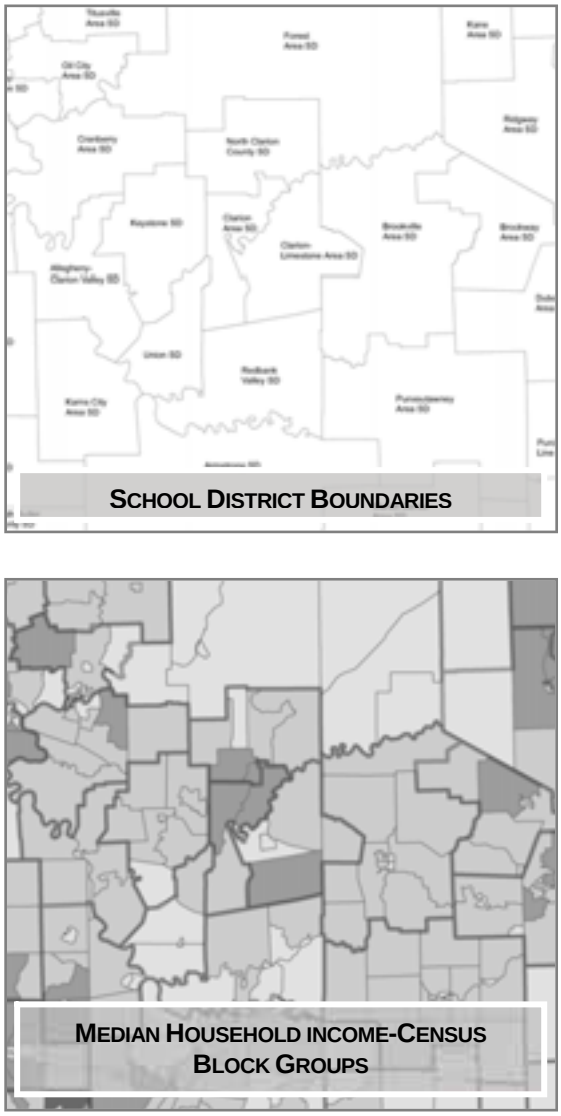


Figure 1

Examples of the collected spatial data: School district boundaries and census block groups.

Non-spatial data, on the other hand, can not be directly represented on a map. Those consisted of the Pennsylvania Department of Education (PDE) SAT data for 2005 (located at PDE website: http://www.pde.state.pa.us/pas/lib/pas/PUBLIC_SCHOOL_SAT_2005.pdf) and records of student admissions at Clarion University for 2004-2005 school year. The 2005 SAT data were in Adobe Portable Document Format (PDF) and included average verbal and math scores and the number of SAT takers for every public school in Pennsylvania. Furthermore, the admissions data were prepared in the admissions office and provided in Microsoft Excel (XLS) format. It contained 54,972 national and international student records that were collected from different sources and were used for recruitment purposes. The data included student addresses, which is important for the geo-coding process (pinpointing addresses on a map), contact information and other data pertaining to their high school and interest in specific higher education majors. Student records could also be identified by date of application and date of enrollment in Clarion University. Only those Pennsylvania records were considered in this study for the purpose of optimizing the processing time of the GIS tools in data processing and analysis.

2.2. Data Pre-processing

Pre-processing and cleanup procedures were required for most of the available data. Following is a description of the processes that were carried out in order to prepare the data for further investigation and analysis.

2.2.1. PDE SAT Data

SAT data was available in tabular format in PDF (Figure 2). In order for the data to be compatible with GIS, it was exported to Microsoft Excel. Records were first organized by school district. The average SAT score for every school district was then determined. The total number of SAT takers for every school district was also calculated. The resulted table was then exported to ArcGIS for further analysis.

				SAT SCORES 2005		
IAUN	DISTRICT	SCHOOL NUMBER	SCHOOL	NUMBER OF STUDENTS	VERBAL	MATH
124170002	21ST CENTURY CYBER CS	7691	21ST CENTURY CYBER CS	19	557	461
110050002	ABINGTON HEIGHTS SD	5091	ABINGTON HEIGHTS HS	291	511	516
123490002	ABINGTON SD	3241	ABINGTON SHS	469	516	536
101260002	ALBERT GALLATIN AREA SD	6001	ALBERT GALLATIN AREA HS	151	465	455
127040002	ALIQUIPPA SD	6554	ALIQUIPPA SHS	41	391	413
103020002	ALLEGHENY VALLEY SD	29	SPRINGDALE JSHS	56	489	523
104160002	ALLEGHENY-CLARION VALLEY SD	4684	ALLEGHENY-CLARION VA	28	525	530
121300002	ALLENTOWN CITY SD	2795	LOUIS E DIERUFF HS	151	452	449
121300002	ALLENTOWN CITY SD	2794	WILLIAM ALLEN SHS	183	463	463
109070002	ALTOONA AREA SD	913	ALTOONA AREA HS	312	499	503
127040701	AMBRIDGE AREA SD	6555	AMBRIDGE AREA HS	162	499	498
113390002	ANNVILLE-CLEONA SD	2725	ANNVILLE CLEONA JSHS	86	500	525
114060002	ANTIETAM SD	829	ANTIETAM MIDDLE/SENIOR HS	58	500	505
126030002	APOLLO-RIDGE SD	2329	APOLLO-RIDGE HS	55	471	479
126513190	ARCH AND DESIGN CHS	7576	ARCH AND DESIGN CHS	54	421	413

Figure 2

Sample PDE Public Schools SAT data for 2005.

2.2.2. Admissions data

Admissions data contained all national and international student addresses. Only those records with valid Pennsylvania addresses were extracted. Applicants to Clarion University and enrollees for the 2004-2005 school year were flagged for easy retrieval. Some data scrubbing was also carried out in order to remove P.O. Box addresses. In case of the existence of two addresses for a specific record, the one that is based in Pennsylvania and has a valid street number, name and type (e.g. 100 Main Street) was used. The resulting records were then made available to ArcGIS (version 9.1) through an ODBC (Open Database Connectivity) connection *(with version 9.2, excel files can be read from the catalog tree without a need for a database connection)*.

2.2.3. Median household income

The median household income block groups were downloaded from the Pennsylvania Spatial Data Access (PASDA) website. The data was provided in an individual file for every county. The data were merged together in order to form one seamless dataset for Pennsylvania.

2.2.4. Road network

Similar to the median household income block groups, individual County shapefiles of the TIGER/Line (Topologically Integrated Geographic Encoding and Referencing) road networks were extracted and downloaded from the Environmental Systems Research Institute (ESRI) website (http://www.esri.com/data/download/census2000_tigerline/index.html). Those files were then merged into one dataset. Due to computational constraints, the resulted seamless road network of Pennsylvania was divided into 10 different zip code zones in order to optimize processing time and performance (Figure 3).

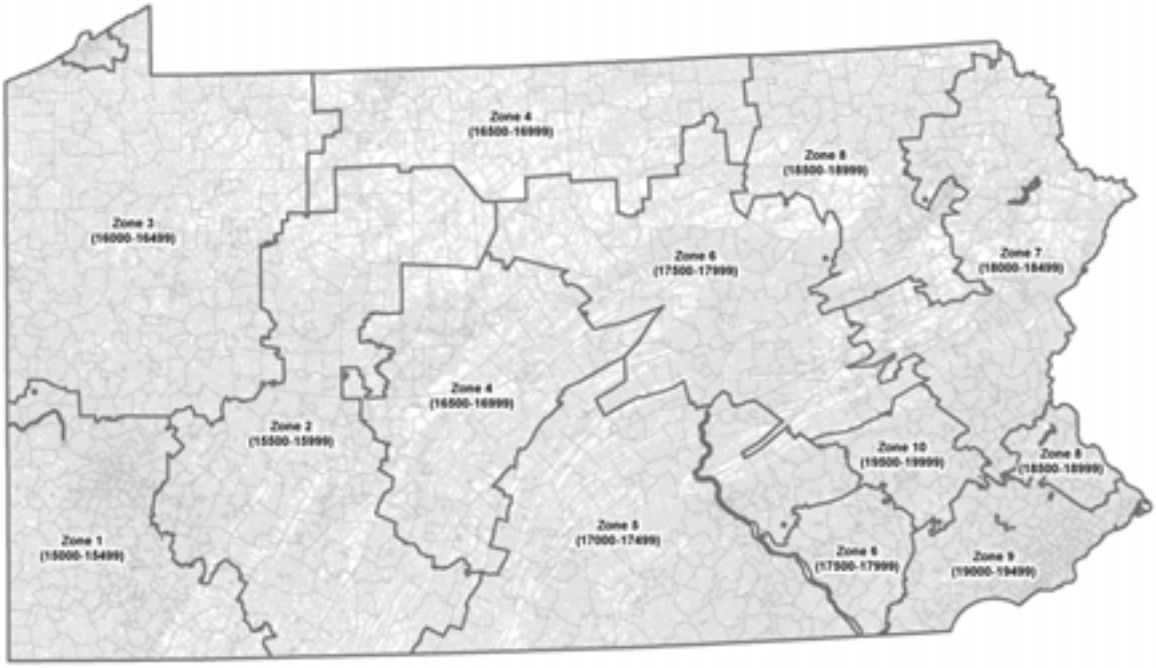


Figure 3

Subdivisions of the street network based on the designated Zip code zones

3. Facts & Demographics

3.1. Population Densities

Figure 4 demonstrate the population density and distribution in Pennsylvania based on the 2000 population counts. Larger urban areas are shown in darker shades and provide basic information about future areas for marketing potentialities.

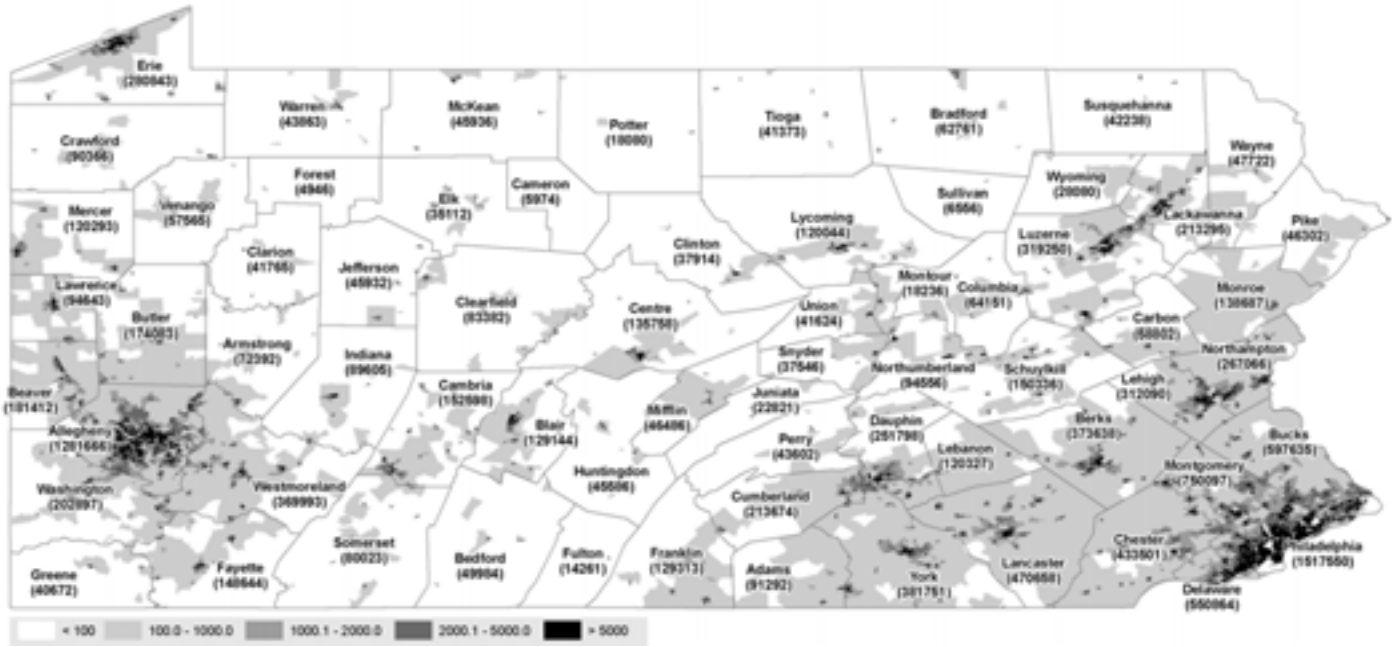


Figure 4
Population Densities in Pennsylvania

3.2. PA SSHE Enrollment

Pennsylvania State System of Higher Education colleges' data were collected and joined with their corresponding location. Figure 5 shows their distribution and their gender composition. It becomes more obvious when overlaid with the population densities that enrollment is mostly higher at those institutions closer to more densely populate areas.

In theory, Indiana, California, Slippery Rock and Clarion draw most of their students from the Pittsburgh area. Edinboro, on the other hand, draws from both Pittsburgh and Erie. It is worthy to note that Clarion University also have the opportunity to serve the more rural northwestern Pennsylvania, and draw students from those same regions due to its central location between the two major cities.

Maps such as Figure 5 would be very beneficial in tracing trends of enrollment in the Pennsylvania State System of Higher Education especially if university-specific data is being used.

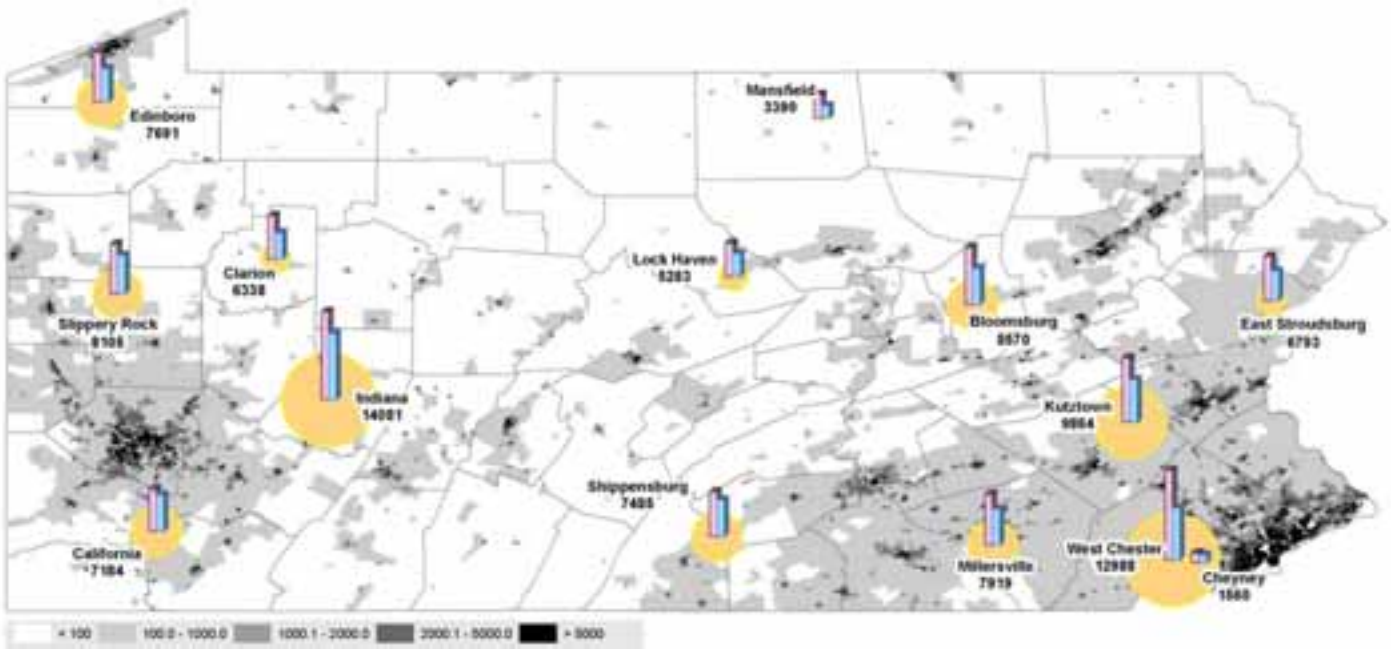


Figure 5

Circles on map shows the 2005 enrollment at the 14 Institutions of the Pennsylvania State System of Higher Education. Bars reflect gender composition at each institution: pink represents the female student population and blue represents the male.

3.3. Average SAT Scores

Data from the Pennsylvania Department of Education (PDE) was compiled and joined with the school district boundaries (Figure 6). This map can be used in the identification of the school district with specific average SAT score. This map is especially useful if the objective is to recruit from school districts with higher scores of average SAT.

3.4. Median Household Income

Figure 7 shows the distribution of the median household income per block group in Pennsylvania. The second group (income group of $25K to $45K) is especially emphasized in this figure due to specific importance that will be explained in more detail in the following chapters: This group reflects the largest population of Clarion University's student body. This map not only relates to the population densities presented in the previous point, but with the average SAT scores as well.

3.5. College-Bound Students

PDE data included the number of students who applied for SAT per school district. This data was summarized and presented in Figure 9. This map is a valuable source of information that may help identifying potential markets for future student recruitment. By itself, it can be considered as a representative of one of the very important factors in tracing marketing strategies: the customers' body.

Philadelphia was the only school district that had 6,715 SAT takers, the highest number of SAT takers for all of the other school districts was in Pittsburg (1,120).

3.6. Clarion University Enrollment

Post-processed admissions data were geo-coded (addresses were pinpointed on the street network), interrelated with the school districts (overlaid), summarized, and joined with the school district boundaries in order to preview the distribution of the number of enrolled students per school district at Clarion University for 2004-2005 (Figure 8).

A simple visual comparison between Figures 8 and 9 reveals certain strengths and weaknesses of recruitment efforts that were carried out for certain school districts. The area of north Allegheny County (North Allegheny, Avonworth, Pine-Richland, and Fox Chapel Area school districts), for example, shows high numbers of SAT takers and low or no enrollment. Same trend is shown in southern Blair (Spring Cove and Hollydaysburg school districts) and Center Counties (State College Area school district).

On the other hand, Clarion University was relatively successful in attracting students from many of the school district that had less than 200 SAT takers and are located in the west (more than 120 miles from Clarion, e.g. East Lycoming in Lycoming County, Lakeland in Lackawanna County, Manheim Central and Ephrata Area in Lancaster County, Avon Grove in Chester County, and Bangor Area in Northampton County) and was unsuccessful to recruit any students in others that had more than 200 SAT takers (e.g. all Monroe County school districts, Parkland in Lehigh County, New Hope-Solebury, Council Rock, Neshamini, and Pennsbury in Buck County, and Penn Manor, Lancaster, Hempfield, and Warwick in Lancaster County).

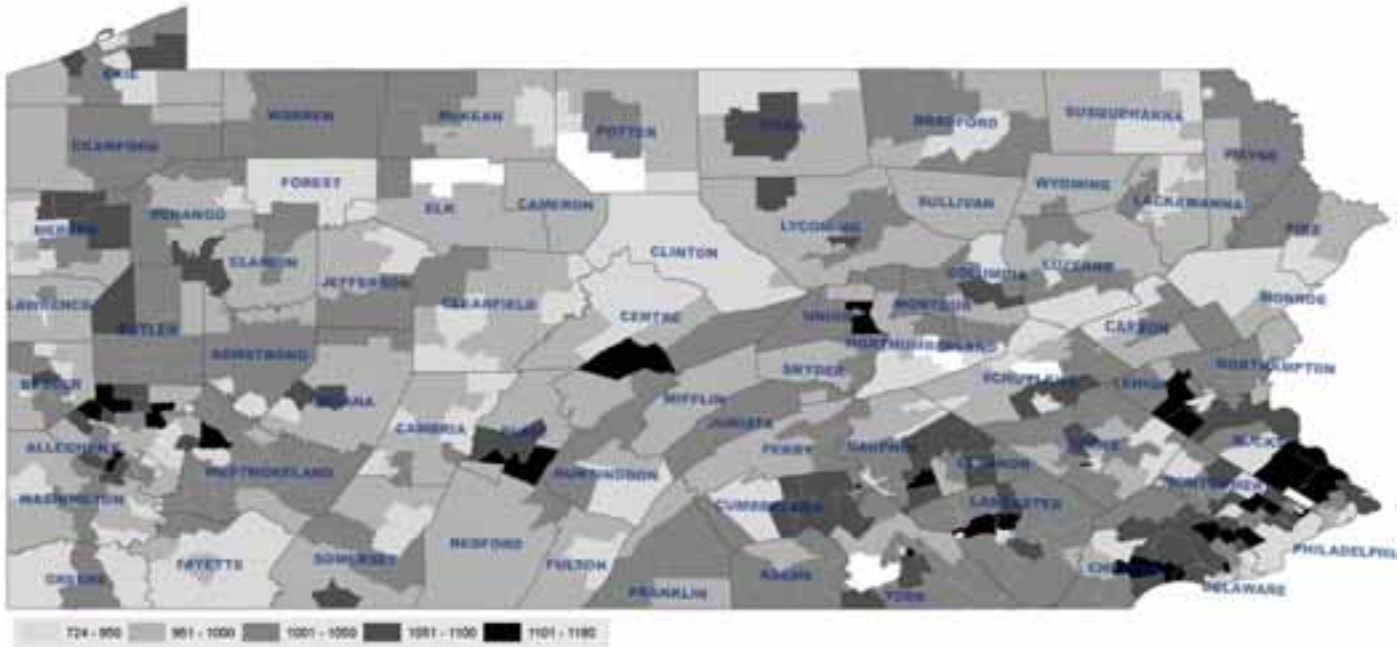


Figure 6

Average SAT scores per school district

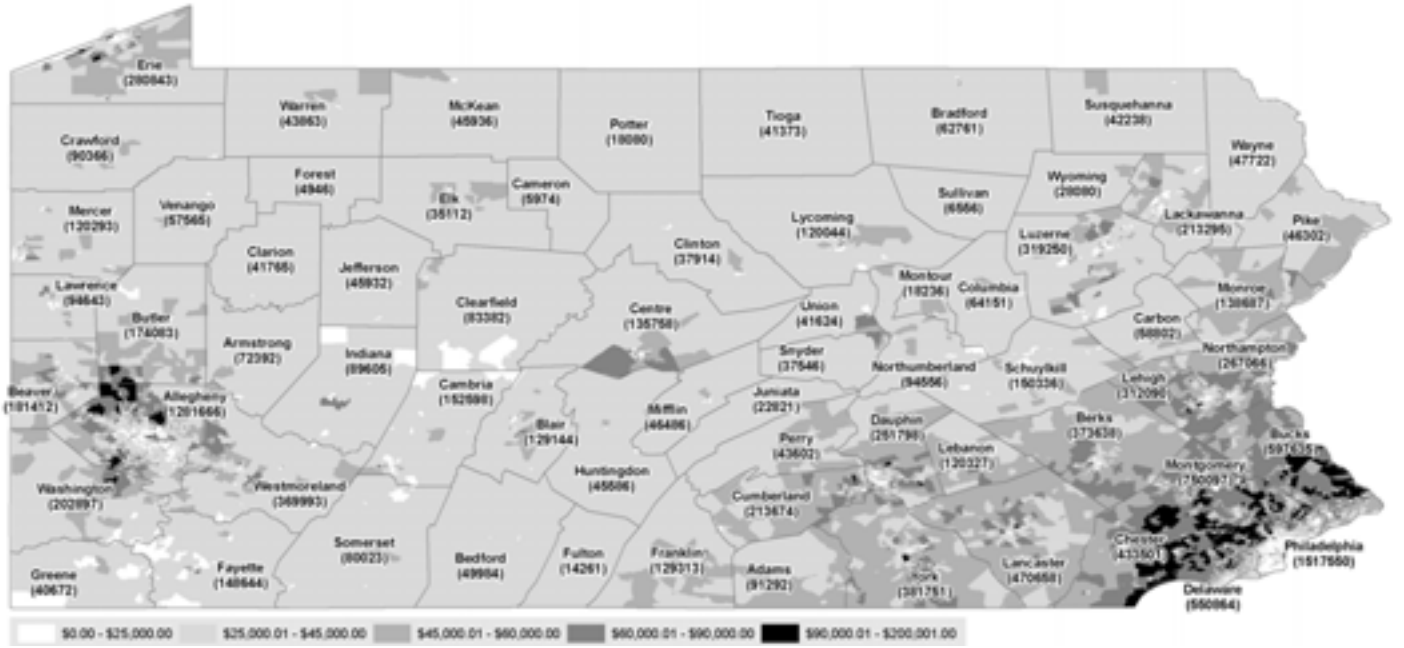


Figure 7

Median household income of Pennsylvania per census block group. Numbers are the population counts per county.

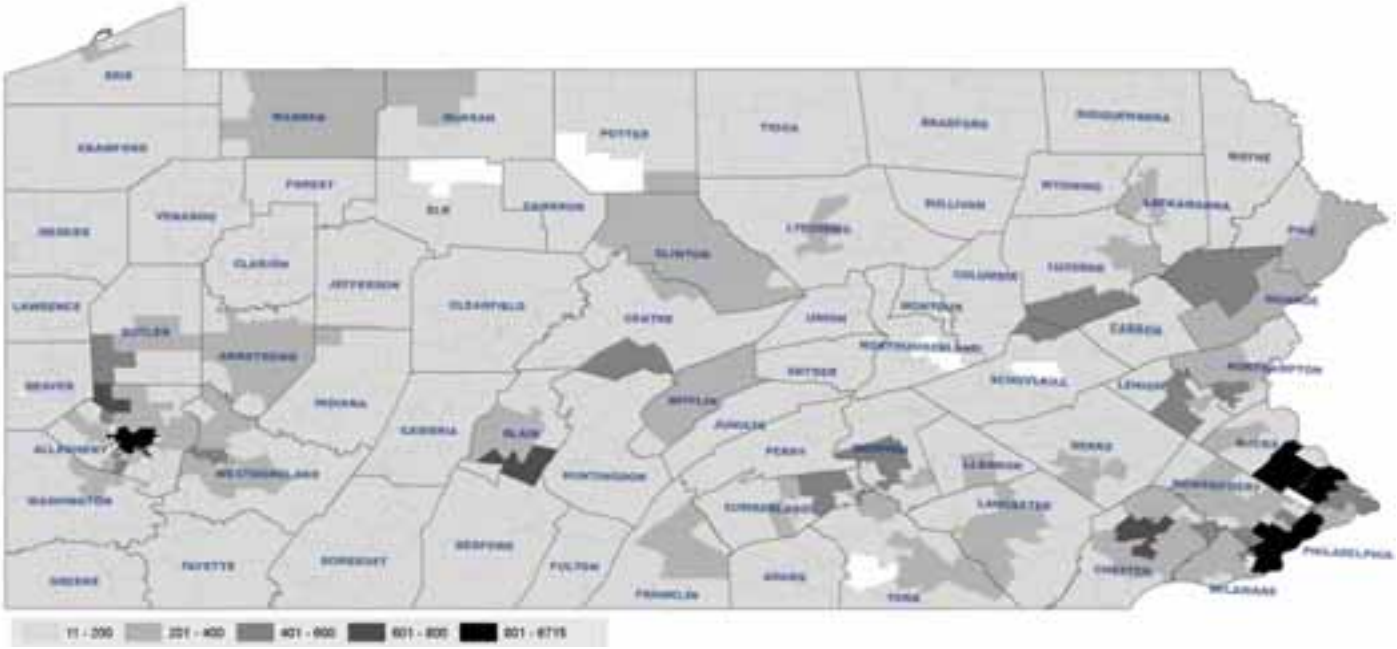


Figure 9
Number of SAT takers per school district

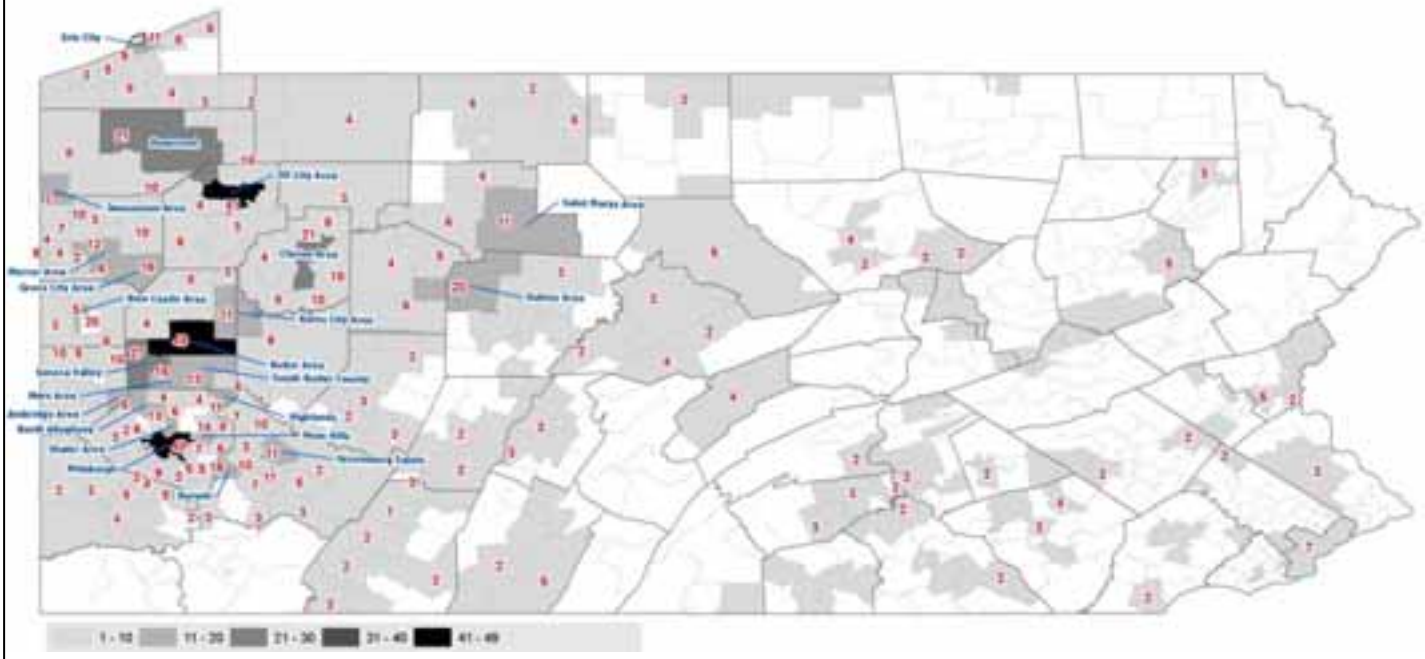


Figure 8
Number of students enrolled at Clarion University per school district.

4. Methods

4.1. Analysis Layout

Evaluating student recruitment and planning for future directions involve two main objectives and directions: market and competition analysis. Both directions constitute integral parts in the successful plan for student recruitment. However, due to the limited data and resources regarding the competitors and competition trends, this study is limited to evaluating the current position of Clarion University enrollment without considering the competition factor. From this perspective, it is advisable that any conclusions or results be taken as a starting point for further investigations.

Analysis in the current study is composed from several phases in order to understand the characteristics of the current enrolled students at Clarion University and to relate those figures with the corresponding school district. Subsequently, measure the potentiality of enrollment of a student from a specific school district (Marting, 2003, Marble et al., 1995, Dramowicz, 2005, Costa, 2004, Davis, 2002, Tang and McDonald, 2002, Thrall and Mecoli, 2003, Christie and Ferris, 2004, Burger, 2004, Lycan, 2005). This was carried out in previous studies by means of applying marketing models. One special and important method in those studies is the application of the gravity model as a market analysis tool (Huff, 2003, Marting, 2001, Martin 2002, Dramowicz, 2005). The gravity model measures the possibility of a customer located between two attraction points (e.g. shopping malls) to travel to one and not to the other based on the utility of each and the traveling distance between the customer and every attraction. The gravity model is depicted in the following formula:

$$I_i = G_i * \frac{N_{SAT_i}}{D_i^2}$$

The gravity index (I) is calculated for every school district (i). Its main concept, in the present study, is to provide a weigh for every school district based on the number of college-bound students (N_{SAT}) in this school district (i) and the corresponding travel distance (D) to Clarion University. A variable (G) is also included in the formula in order to reflect the importance of other factors such as a targeted median household income group or a certain performance level based on average SAT scores in the designated school district (i).

Based on this formula, a school district with high number of SAT takers (N_{SAT}) and is closer to Clarion University would be given a higher weight than a school district with fewer SAT takers and that is located at a further distance.

The following topics will extract every variable required to run this formula. Figure 10 shows the different phases for this study and the main steps involved in each. The variable G will be calculated for every school district based on a classified average median household income. This classification will be deduced from actual Clarion University enrollee data.

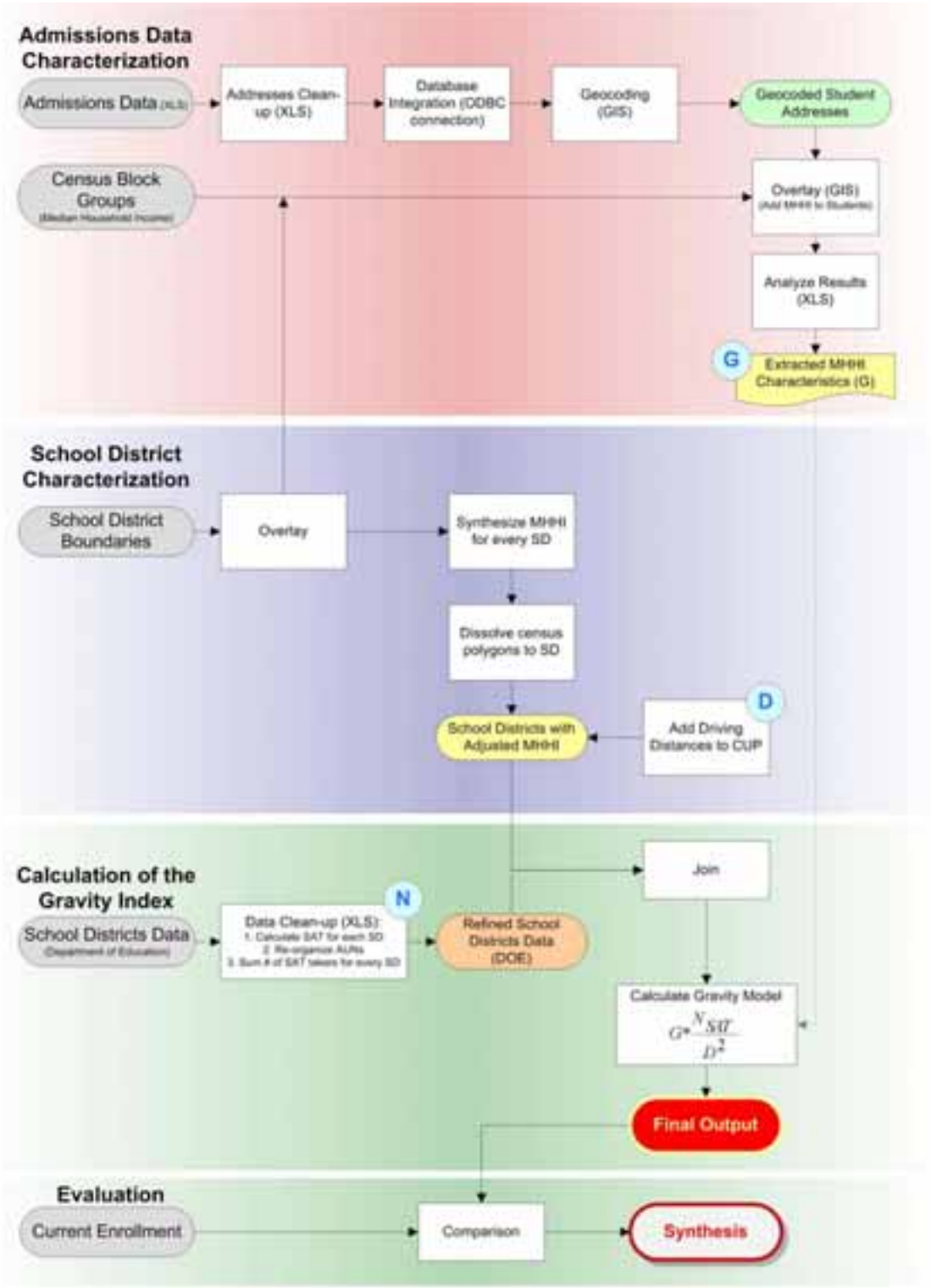


Figure 10

Different phases of the current study and the four main steps involved in each: Characterization of Clarion University's Students, School district characterization, calculation of the gravity index, and Evaluation.

4.2. Characterization of Clarion University Students

The aim of this phase is to understand the composition of the current Clarion University enrollees, and to extract the variable G of the gravity model equation explained in the previous section. The variable G in the current study is based on the median household income, which was one of the factors that many officials at Clarion University have showed interest in including in the present analysis procedures. Also, the collected student addresses were translated to GIS database format through an OLE (Object Linking and Embeding) DB connection. Subsequently, the student addresses were geo-coded using Pennsylvania street network and a US Streets Address Locator in ArcGIS.

Automatic matching process was applied for geo-coding. From a total of 44,713 student records provided by the Admissions office for the 2004-2005 School year, 86.35% were geo-coded, about 77% of the 1,551 actual enrollee students in 2004-2005 were successfully geo-coded. The unsuccessful 23% had P.O. Box or non-9.1.1 compliant addresses, and therefore were impossible to be automatically geo-coded. Many of those unsuccessful addresses can be manually geo-coded which would require more time and manpower as it is a time consuming process, and have its own difficulties and challenges.

Census data (Median Household Income) were collected for Pennsylvania at the block group level (see appendix A) and intersected with individual student addresses (refer to the following section "Characterization of the School Districts" for a detailed description of the adopted procedure). The result is a set of student addresses (points) that are linked to the median household income of the corresponding census block group. Figure 11 summarizes the resulting data. It shows the scatter plot that represents the student's SAT score and the corresponding median household income. The scatter plot shows that about 23% of the total enrolled students were assigned a corresponding median household income of $31,250.

The weighing variable G was based on four classes (Table 1). Most of Clarion University students fall within the $25K-$45K median household income range (71.4%) which was given the highest weigh value. The second class represented those students with an assigned median household income falling between the ranges of $20K-$25K and $45K-$60K (18.5%). The third and fourth classes represented 5.6% and 4.6% of the recruited students respectively. It was assumed that median household incomes of $60K-$80K are more likely to come to Clarion University than those falling within the ranges of $10K-$20K and $80K-$120K. It is recommended that this assumption, and the presented classification, should be studied in more details for more accurate figure of the weighing factor (G).

Table 1

Classification of the median household income groups and the assigned weighing variable G.

Class	Low (1000x)	High (1000x)	Approx. %	Weight (G)
1	$25	$45	71.40	1000
2	$20-$25	$45-$60	18.50	100
3	$60	$80	5.60	10
4	$10-$20	$80-$120	4.60	1

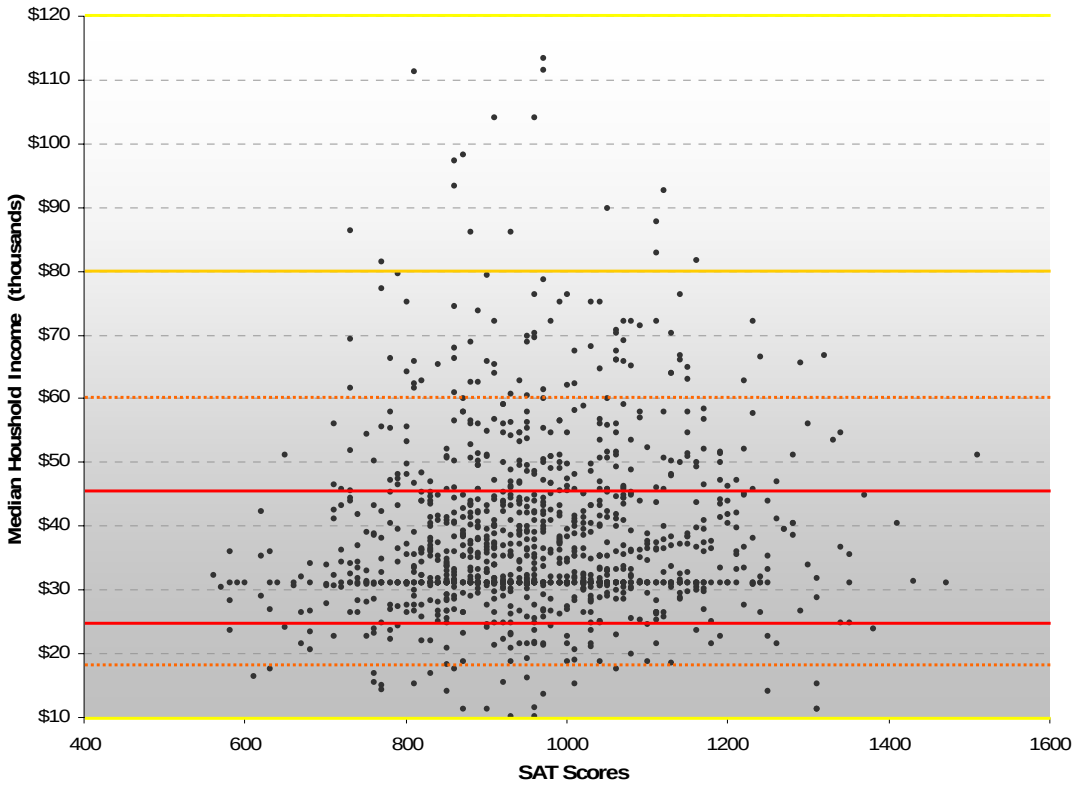


Figure 11

The scatter plot of Clarion University students for the 2004-2005 school years showing the classification of median household income groups based on the visual interpretation and preliminary statistical data. SAT scores are showed as additional information for future reference. Most of the students fall within the $25K-$45K range.

4.3. Characterization of the School Districts

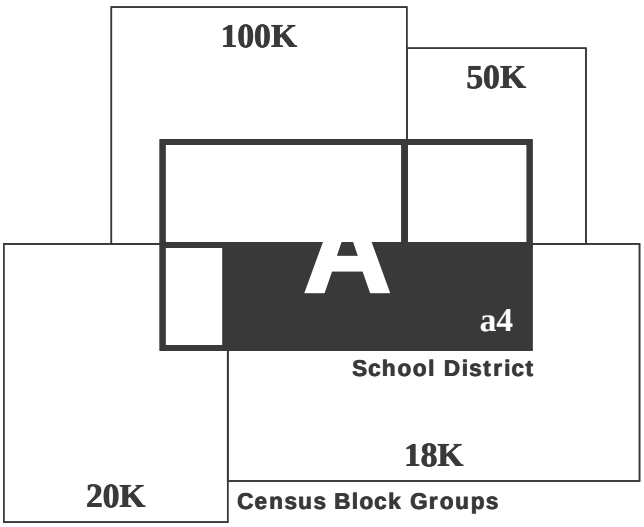
In many cases, the school district boundaries do not match those of the census block groups. In order to identify the school district by its corresponding median household income an averaging method was used. The census block group and the school district boundaries were intersected and the corresponding averaged median household income values were calculated for every intersecting polygon. The calculated averaged median household income for the smaller intersecting polygons of every school district were then added and merged with each other in order to recover the original school district boundaries (Figure 12). The resulting school districts contained a field with the newly calculated (adjusted) average median household income (Figure 14).

Actual driving distances from each of the school districts and Clarion University was calculated and added to a new field in the school district polygons; those values were used in the gravity model formula (D).

4.4. Calculating the Gravity Index

As a final preparation step, the SAT data for every school district was manipulated. Number of SAT takers per school district was derived from the Pennsylvania Department of Education data (PDE), and the average SAT score per school district was also calculated (Figure 13). Although the Verbal and Math components of the SAT were provided in the PDE report but they were not included in this study. It is advised that, for future detailed studies, those scores can be included in order to tailor the recruitment process for a specific academic program.

The resulting table (Figure 13) was then joined to the school district polygons and the gravity index equation was applied by means of calculating a new field in the school district polygons' attribute table. This field (Gravity_Index) holds the calculated Gravity Index values for every school district.



$$\sum MHHI_i * \left[\frac{a_{ij}}{A_j} \right]$$

Figure 12

School districts and census block group boundary issue that was resolved by means of multiplying the median household income by the corresponding intersecting area to total school district area ratio. For the given equation: $MHHI_i$ is the Median Household Income of Census Block Group (i), A_j is the total area of school district (j), and a_{ij} is the Intersecting area between Census block group (i) and School District (j).

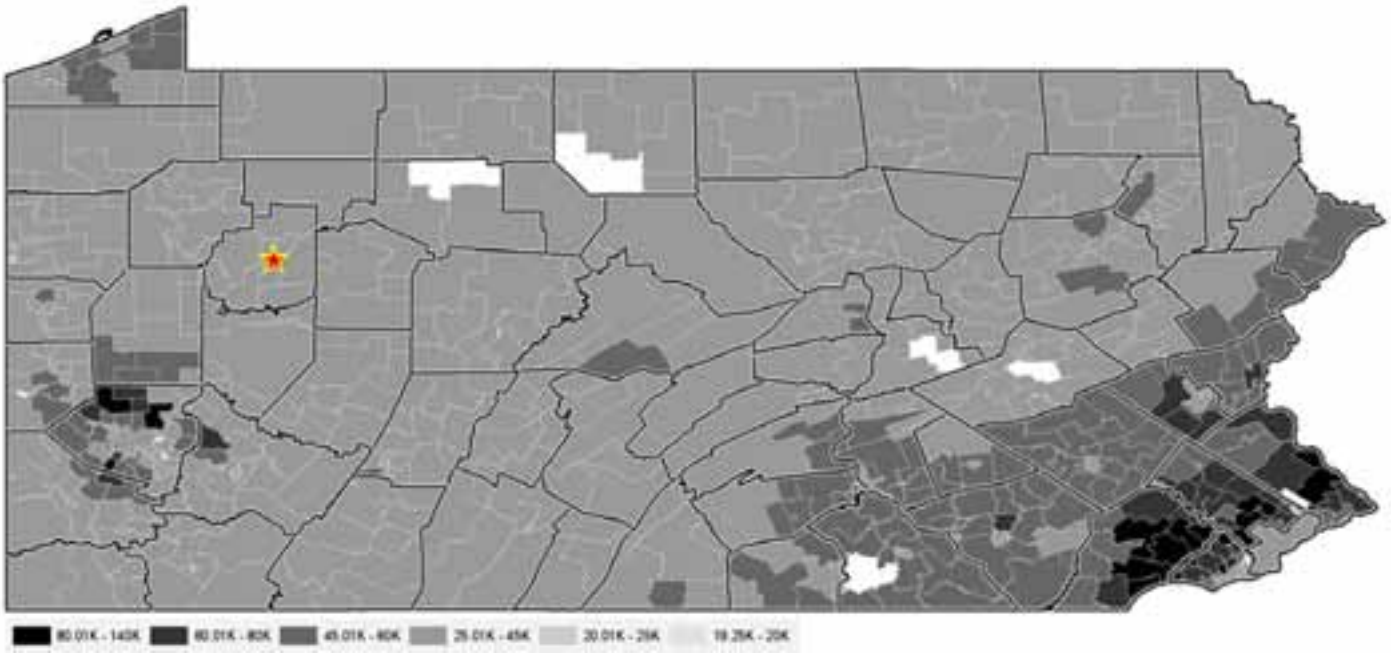


Figure 14

Adjusted Median Household Income data for Pennsylvania school districts.

AUN	Number of Schools Per SD	Number Of Students Per SD	Average SAT Per SD
126515001	48	6,715	801.65
102027451	10	1,120	977.43
105628302	4	274	1,026.44
128030852	4	231	1,000.16
105201033	3	104	977.25
105204703	3	164	1,017.15
105252602	3	86	904.33
117596003	3	104	923.82
118408852	3	257	979.86
122092102	3	1,094	1,101.13
104432903	2	166	957.53
105201352	2	196	1,029.22
107654903	2	86	1,031.74
107657103	2	490	938.88
108051003	2	98	981.16

Figure 13

Refined school district data: database table containing the school district unique ID (AUN), the number of students per school district, and their average SAT score.

5. Results

In the following paragraphs the results from calculating the Gravity Index for every school district in Pennsylvania is presented. Furthermore, other manipulations to the data will be also presented in order to broaden the vision on the possible consideration of variables such as the number of college-bound students and the median household income relative to each school district. Also, a comparison of the results with the enrollment trends at Clarion University for 2004-2005 is presented in order to help in the decision making process for future marketing plans.

5.1. Gravity Index

Figure 15 represents the distribution of the calculated Gravity Index across Pennsylvania. Ten different quantile classes are used; every class includes approximately 49 school districts (491 school districts in total – the total number of school districts in PA is 591, 10 of which had no SAT data). The effect of including the median household income data is clear especially in the suburban areas of Pittsburgh in the south west and of Philadelphia in the south east. The later is also affected by the distance from Clarion University main campus. Although the Philadelphia school district is most distant from Clarion but it had a high Gravity Index (68.54) due to the high numbers of college-bound students (6,715 SAT taker). The highest Gravity Index value was recorded for Clarion-Limestone area school district (3,061.73), followed by Clarion area (517.01), Keystone (462.59), and Redbank Valley (193.70); all are closest to Clarion University main campus.

As a detailed figure, the highest group of school districts, which would be, mostly, the closest to the Clarion University's campus, were classified and presented on a separate map in order to categorize its school districts (Figure 16).

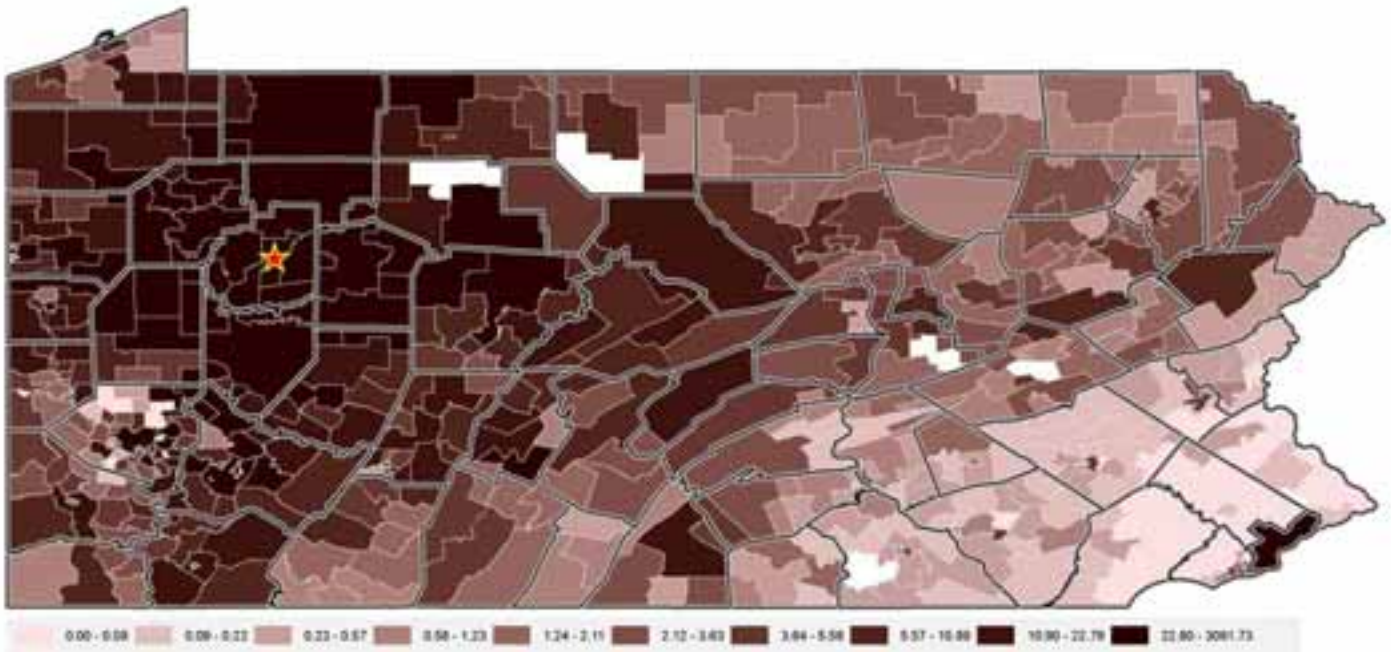


Figure 15

Ten different classes of the resulting Gravity Model Index (including the median household income as a weighing factor).

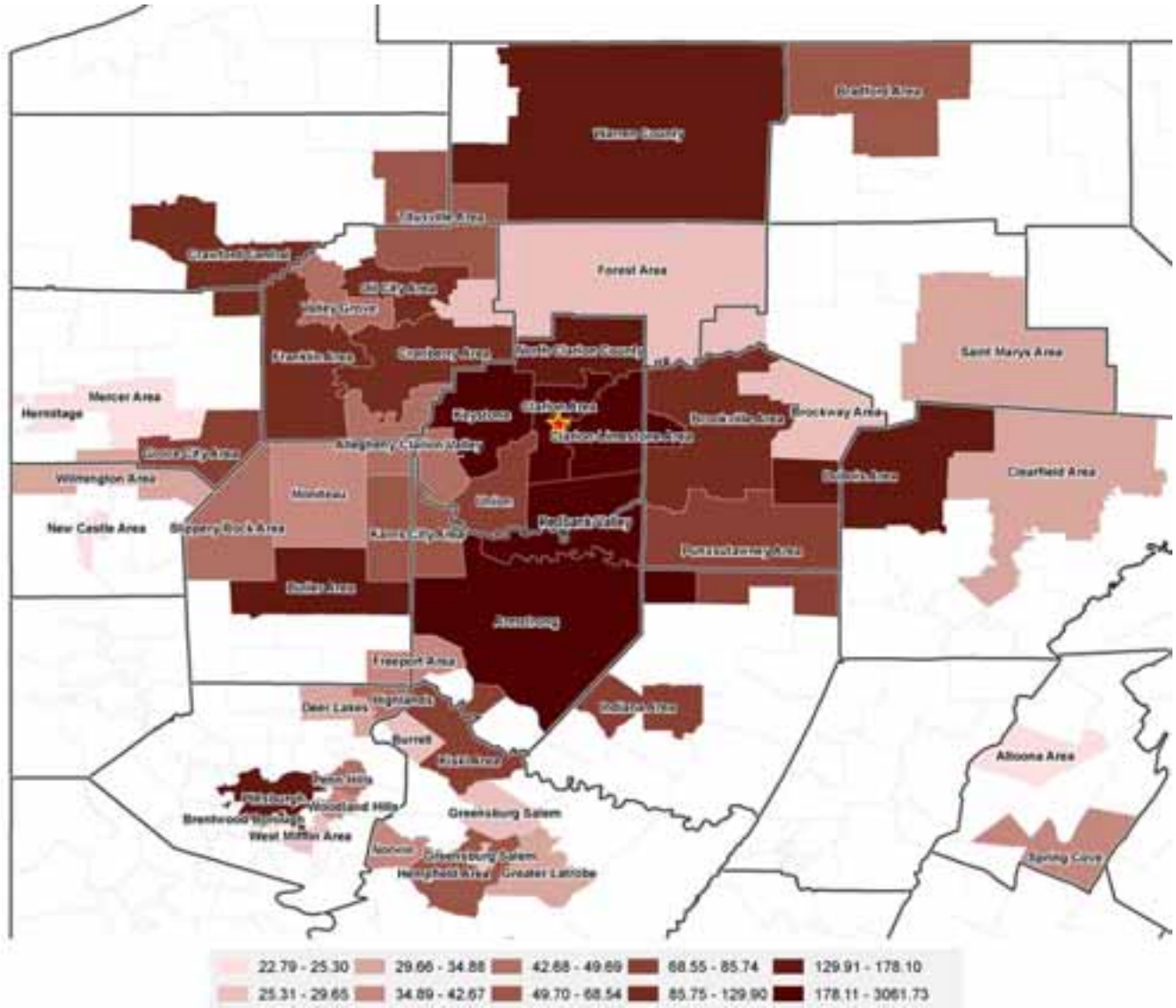


Figure 16

A Detailed map of western Pennsylvania: Data include those school districts with a Gravity Index score of more than 22.79 which represents the highest 49 of the given 491 school districts.

5.2. Modified Gravity Index

In order to eliminate the effect of the median household income on the given data, the weighing factor G was excluded in the calculation and results were presented in (Figure 17). This was clearly reflected in the inclusion of Pittsburgh, Philadelphia, and Harrisburg suburban school districts. Many of the northeastern and southern school districts scored a low Gravity index, although some of them were closer than others but their student numbers (N) was much higher which would reveal a better market in terms of potential "customer" base.

In terms of SAT takers and vicinity to Clarion University in northwestern Pennsylvania school districts, North Allegheny and State College area showed good potentials for recruitment (Figure 18). But the

main school districts that were ranked highest in Figure 16 were also the highest in Figure 18 (e.g. Clarion area, Keystone, Clarion-Limestone, Redbank valley, Armstrong, Butler area, North Clarion County, and DuBois area).

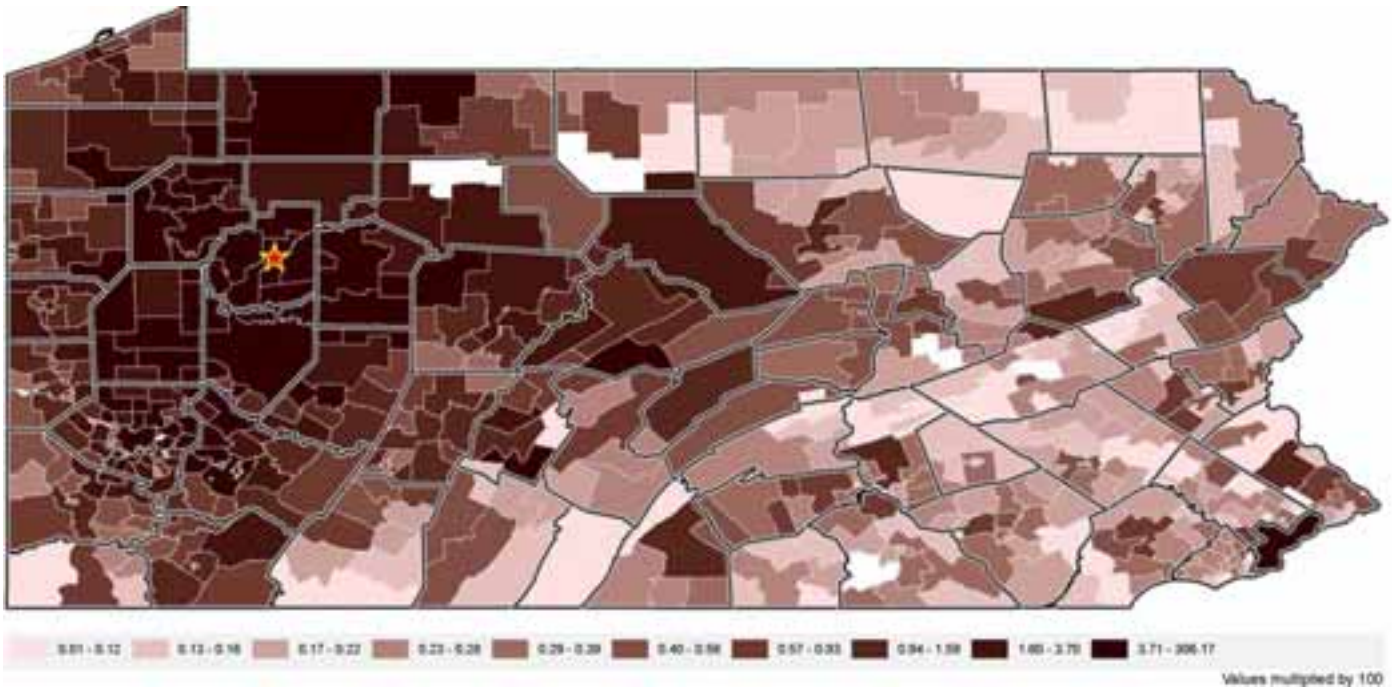


Figure 17

Ten different classes of the resulting Gravity Model Index (excluding the median household income as a weighing factor).

5.3. Comparison with Enrollment Trends

The school districts with low (7 students or less, coded "1") or no enrollment (coded "0") at Clarion University were identified (Figure 19) and cross-referenced with the results of the Gravity Model. Other enrollment classes such as moderate (8-30 students, coded "2") and high enrollments (31-49 (maximum) students, coded "3") were also identified but not used in the current assessment. Gravity Index values were classified into 3 categories: A-High (>4.76), B-Moderate (0.8-4.76), and C-Low (<0.8) (Figure 20). The combinations "*A0*" (High Index with no enrollment) and "*A1*" (High Index with low enrollment) were then extracted as shown in (Figure 22), this resulted in a total of 135 school districts, 36 of which were in the first category (*A0*).

In order to connect the results from applying the Gravity Model with the actual "customer" base (i.e. number of college-bound students (SAT takers)), a query was created in order to extract those having more than 100 SAT takers (Figure 21). The total extracted number of school districts was 59, 13 of which were in the first category (A0).

The final graph (Figure 23) summarizes the number of school districts in every category. There were 36 school districts with high gravity index values and no enrollment at Clarion University. Those should be considered a high priority in future marketing plans. Also, 91 school districts had high gravity index and low enrollment.

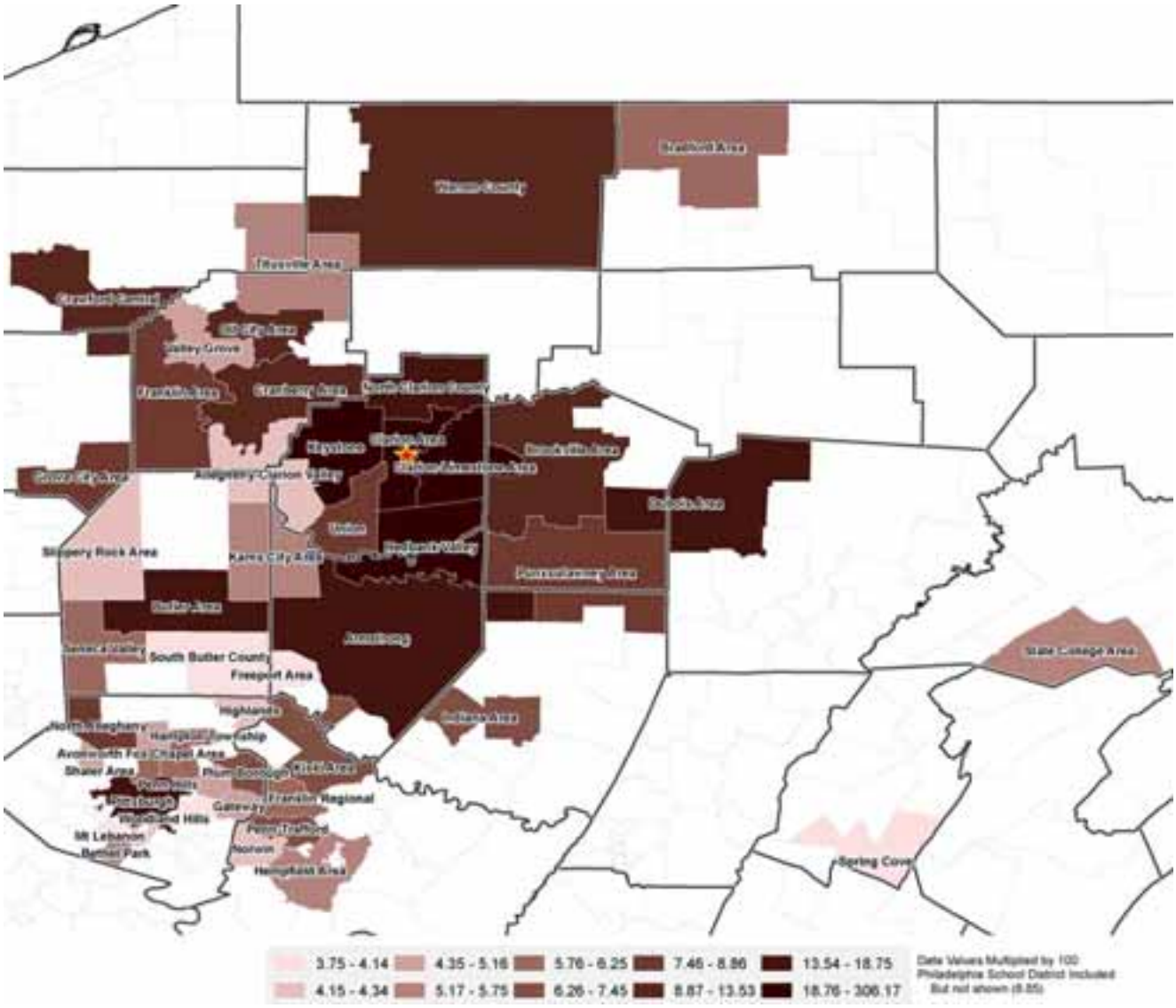


Figure 18

A Detailed map of western Pennsylvania: Data include those school districts with a Gravity Index score of more than 0.037 (multiplied by 100 in the figure) which represents the highest 49 of the given 491 school districts.

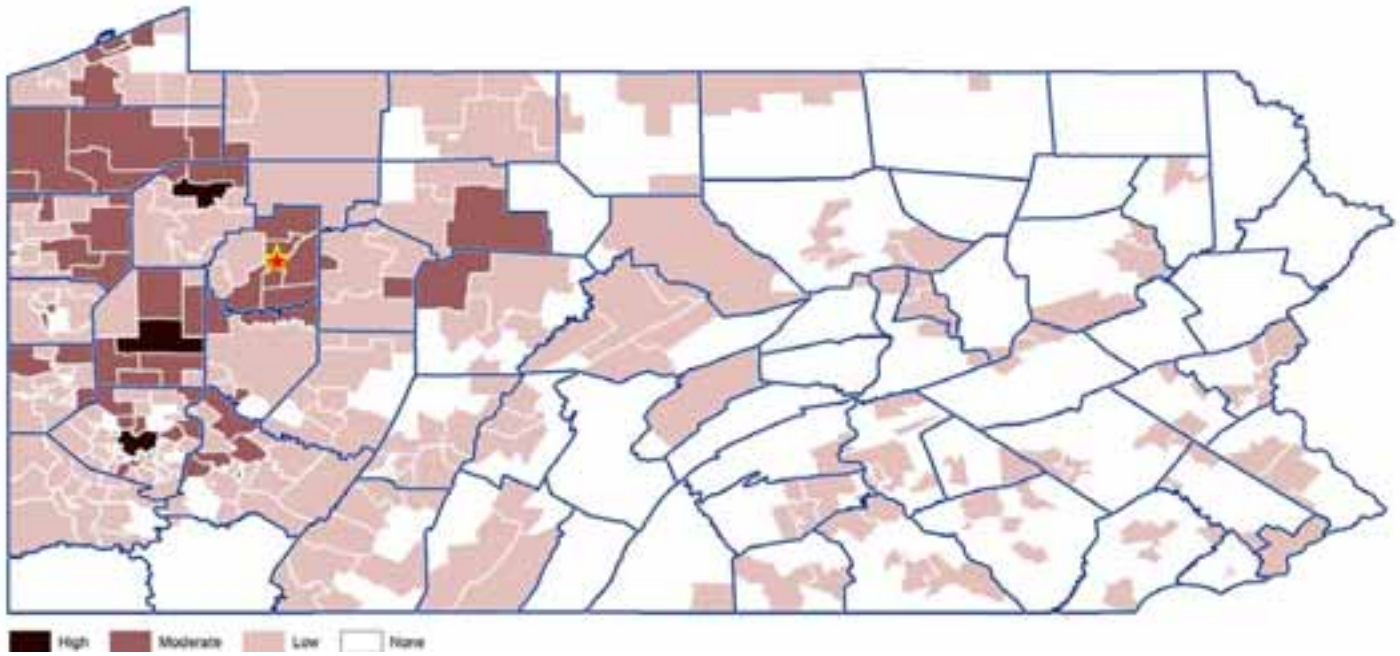


Figure 19
Classification of enrollment at Clarion University

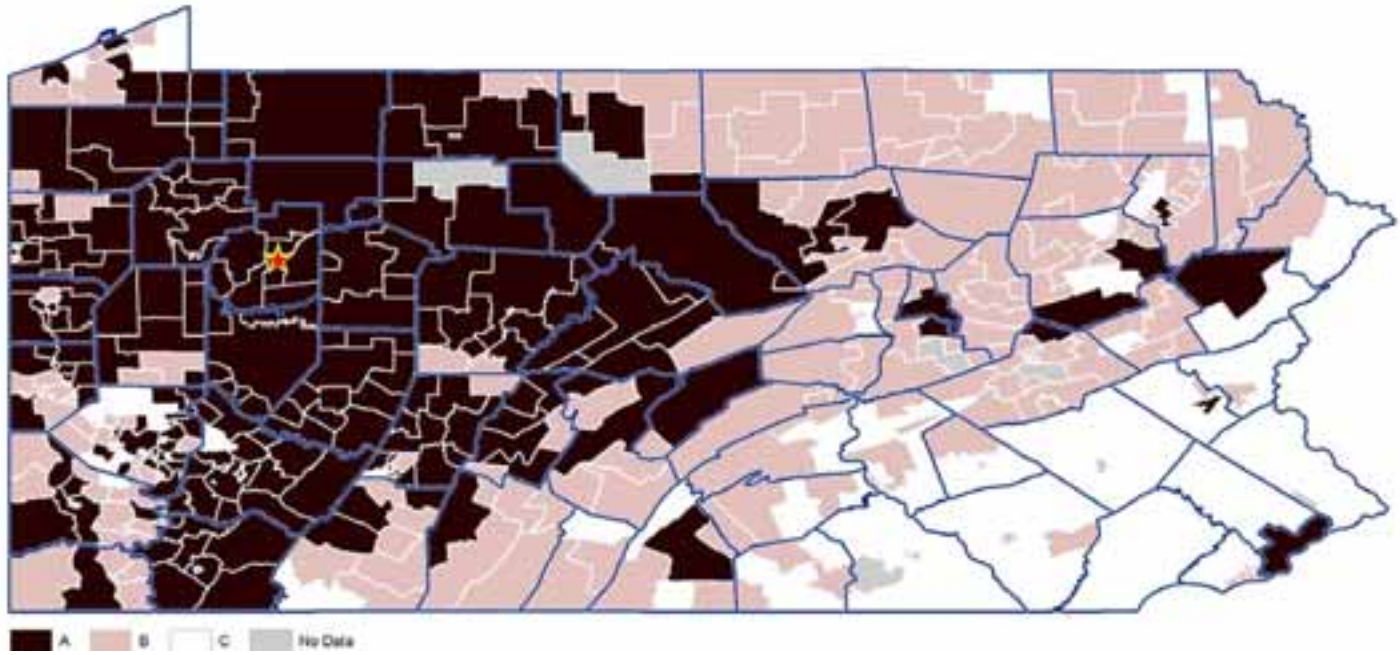


Figure 20
Gravity Index Classes: A-High, B-Moderate, and C-Low Gravity Index value.

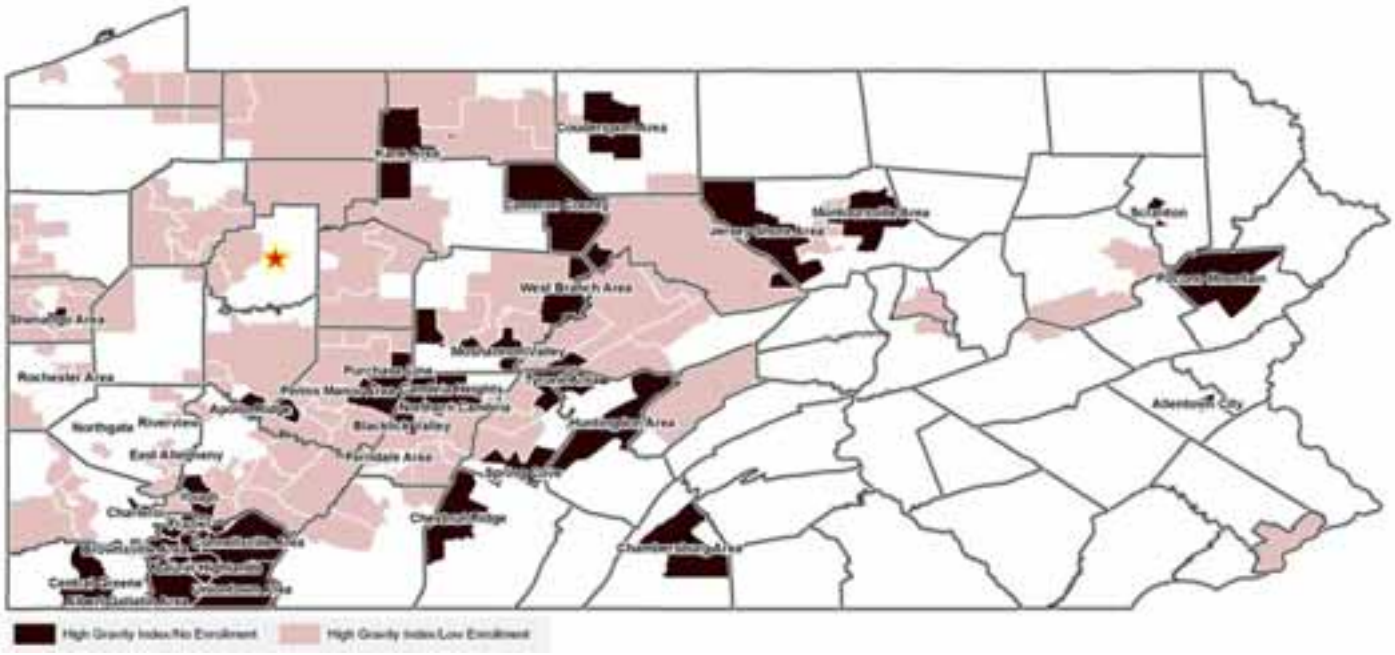


Figure 22

School districts with low or no enrollment at Clarion University that scored a high Gravity Index

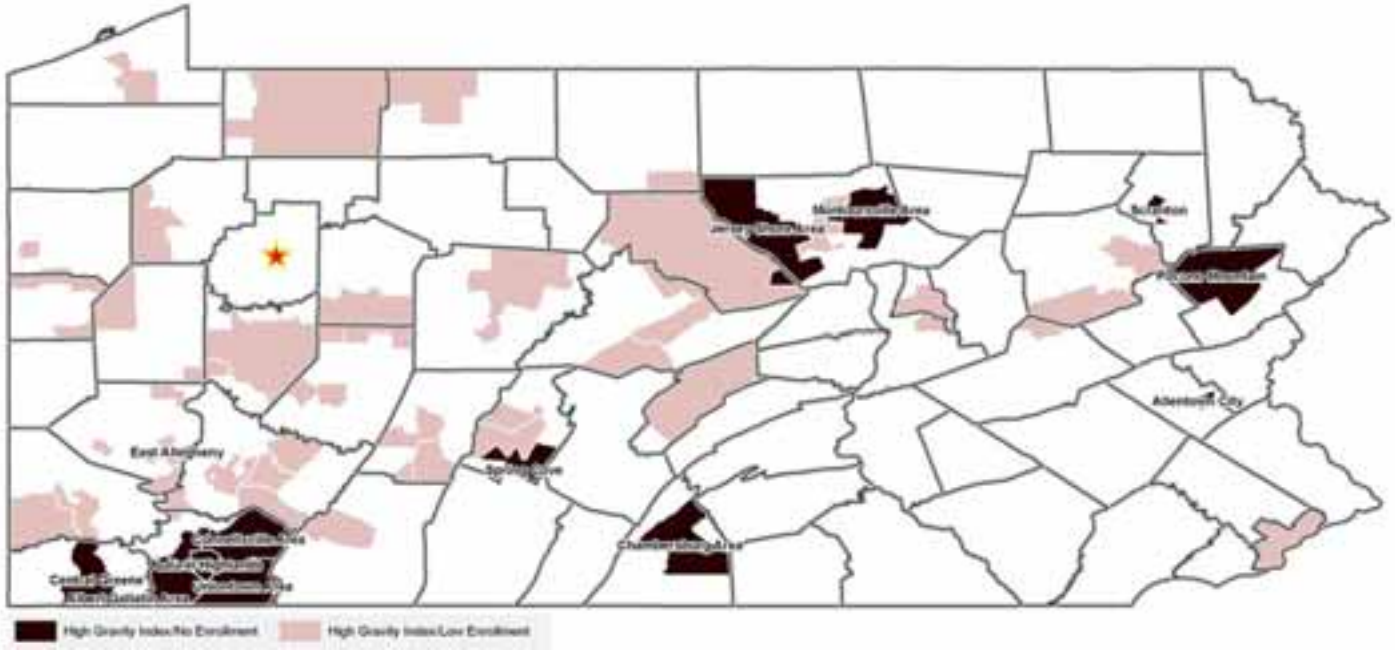


Figure 21

School districts with low or no enrollment at Clarion University that scored a high Gravity Index and had more than 100 college-bound students (SAT takers).

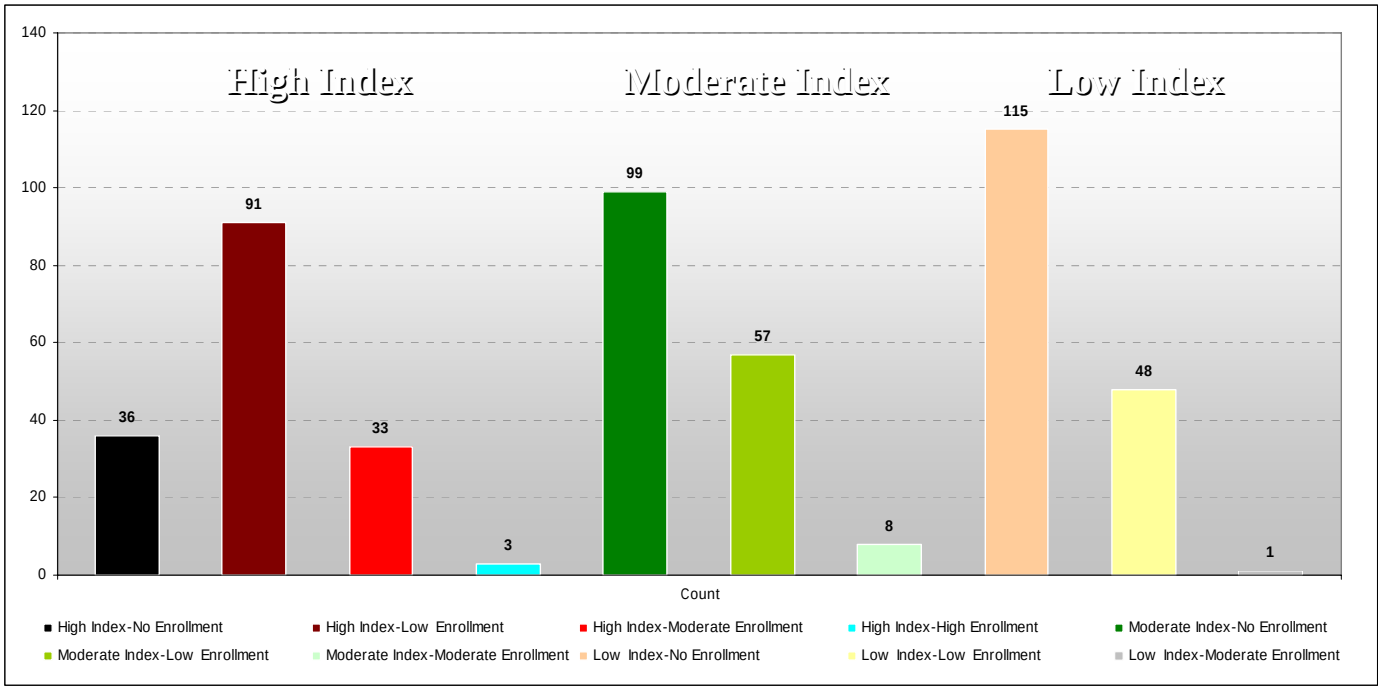


Figure 23

Summary graph of the number of school districts in each category. The total processed school districts were 491 out of 501. The missing 10 school districts had no SAT takers in the 2004-205 school-year.

6. Conclusions & Recommendations

The present study discussed three main topics: the characterization of Pennsylvania school districts, the examination of the current student body at Clarion University, and the evaluation of the enrollment trends at Clarion University. The analysis was mainly based on a Gravity Model, in which, factors such as the number of college-bound students (SAT takers), median household income group, and the driving distance to Clarion University played an important role in affecting the final results. Based on those results, the school districts that represent potential market for future student recruitment were extracted. Also, those having high potentials and no or low current enrollment at Clarion University were identified.

This study represents the potentials of incorporating demographic and admissions data in a Geographic Information Systems (GIS) analysis, by which many spatially-related questions can be answered, and other prospective venues can be traced.

6.1. Technical issues

Data collection was a relatively simple task. It required some time for compilation due to the extents and the size of the area of interest (State-level), some computational problems arose due to hardware and software limitations. Those problems (e.g. geocoding) were settled by means of subdividing the state into regions and performing some tasks in sections. The final result of those tasks was summarized and merged in order to give the broader vision of the study area.

Other repetitive and time consuming tasks, such as adding and calculating fields, performing overlays, and data clean ups, were better handled using models and parameters. Those modeling tools, usually available within capable GIS packages, are very useful in applying multiple changes at different analysis strategies without having the need to manually re-run every task involved in the analysis.

6.2. Analysis Aspects

This study revealed the importance of the number of college-bound students as the basis of any recruitment strategy. Other factors such as the median household income and the driving distance to the university can represent a role element in the analysis. Other factors that can be also considered are the number of academic programs as compared to the competitor institutions, family size, and financial aid opportunities. A combinatorial factor can be tailored depending on the aim of the process, in order to conceive a better indicator for an effective recruitment strategy.

Other models can be applied and tested to the current, or modified, data. A re-assessment of the recruitment outcomes that will be based on the given results is recommended. A detailed feedback from the admissions office would play an important role in refining and re-directing the current analysis methods and the data involved. The iteration of the model with input from the feedback and from other sources would improve on the results and enhance the adopted methods.

6.3. Recommendations

- The travel distance might be considered as a barrier factor for Clarion University's efforts of recruitment due to cost of travel and/or marketing in areas distant from Clarion. Several arguments were concerned with the importance of the distance as a factor for preventing students from applying in a distant campus. Some have argued that many students will prefer to travel than others. Although this statement can be true, but in most cases

the travel distance is considered as a barrier to college selection. It is recommended that, if recruiting from distant school districts (potentially with high numbers of college-bound students), incentives be provided to traveling students in order to attract them to the Clarion area.

- The median household income might be given more or less weigh depending on the target market group. In this study, suggested class breaks were used based on the visual interpretation of the scatter-plot of student's median household income groups. Also the weighing factor for each of the identified classes was based on the general consensus of the preference of one income group to the others (mainly the $25k-$45k range). It is recommended that the weighing factors would be either based on more robust statistically identified parameters or targeted to a specific median household income group.
- The number of college-bound students (SAT takers) can be given a greater weigh in the Gravity Model formula, since it can be considered as an especially important factor in recruiting large numbers. Small percentage of recruited students from a school district with a very high number of college-bound students might result in higher number of recruited students compared to other school districts with smaller number of college-bound students with higher recruitment percentage.
- The current study can be customized to evaluate the recruitment for any specific major or program depending on the objectives and the factors to consider in the calculation process. The major of interest, for example, is a possible variable that existed in the admissions data but was not included in the present study.
- Timing is an important factor in GIS data analysis. Data preparation is a time consuming task, therefore, it is recommended that a proper time, software, hardware and personnel to be given in the preparation and analysis procedures in order to ensure accurate and reliable results.
- Reports, tables and maps can be extracted in a customized fashion for the data involved in this study. Many of which are applicable for future dates; such as the number of SAT takers (which would not change dramatically between years), median household income, and the driving distances. Other data, such as Clarion University enrollment at a specific date and the number of students enrolled from a specific school district can be easily updated and linked with the current information in order to support future recruitment and marketing efforts.

7. References

Huff, D. (2003). Parameter Estimation in the Huff Model. ArcNews magazine October-December 2003.

Martin, R. (2001). Identifying Target Enrollment Areas to Improve Diversity. ESRI User Conference Proceedings 2001, San Diego, CA.

Martin, R. (2002). Identifying Target Enrollment Areas to Improve Diversity, Part 2. ESRI User Conference Proceedings 2002, San Diego, CA.

Marting, R. (2003). Stalking the 'Nerds' or Where are the Science Majors? ESRI User Conference Proceedings 2003, San Diego, CA.

Marble, D., Mora, V., and Herries, J. (1995). Applying GIS Technology to the Freshman Admissions Process at a Large University (1). ESRI User Conference Proceedings 1995, San Diego, CA.

Dramowicz, E. (2005). Retail Trade Area Analysis Using the Huff Model. Locationintelligence.net, July 02, 2005.

Costa, J. (2004) GIS with DM: Just Tools, or a New Marketing Science? ESRI User Conference Proceedings 2004, San Diego, CA.

Davis, G. (2002) GIS Helps Plan for K-12 Enrollment. ArcNews magazine, Winter 2001/2002.

Tang, H., and McDonald, S. (2002). Integrating GIS and Spatial Data Mining Technique for Target Marketing of University Courses. Proceedings of the Symposium on Geospatial Theory, Processing and Applications, Ottawa 2002.

Thrall, G. and Mecoli, N. (2003). Spatial Analysis, Political Support and Higher Education Funding. Geospatial Solutions, July 2003.

Christie, R., and Ferris, M. (2004). Spatial Analysis for Enrollment Planning in Higher Education. ESRI Education User Conference Proceedings 2004, San Diego, CA.

Burger, P. (2004). Market-Area Analysis – Not Just for Business Anymore. Geospatial Solutions, May 2004.

Lycan, R. (2005). Linking Tax-lot and Student Record Data: Applications in School Planning. ESRI User Conference Proceedings 2005, San Diego, CA.

Yasser M. Ayad
Associate Professor, GIS
Clarion University of Pennsylvania
Department of Anthropology, Geography, & Earth Sciences
814.393.2990
814.393.2004 FAX

yayad@clarion.edu