International Journal of Intelligent Computing and Information Science

GIS Utilization for Strategic Planning Service Delivery Based on Service: Location, Time, And Type; A Case Study: 1st Primary Schools' Strategic Planning in Mansoura City.

Shabana, Bahaa Taher*
Computer science, Misr Higher
Institute of Commerce and Computers (MET),
Mansoura, Egypt.
bahaashabana@yahoo.com

Abstract: *Smart cities are new and evolving concept based on innovative information and communication technologies. Thinks and Internet of Thinks (IoT) must be core technologies in smart cities. Thinks' services and maintenance must be managed through digital planes. Location based service (LBS) are service targeted to a wide range of users. The increasing number of LBS will have a bad impact on transitions. One of the objectives of building smart cities is to reduce the traffic congestion and transportation demand. This paper utilizes Geographic Information System (GIS) and spatial analysis techniques for decision support of LBS. the objective is the advance determination of the best service location for covering services requirement based on three factors: location, time and type of service.*

Education is the greatest service required for humanity. This paper focuses on considering service factors and client requirements by applying a developed GIS platform to inform service provider by the assets required to cover customer needs and meets smart cities goals. While 1st stage of primary schools accepts students in age of 6 years, the suggested platform determines schools' plane for 5 years in advance, according to: student location, date of birth, and education type requirement.

The suggested platform was applied on Mansoura city, Egypt. That platform was designed by: using geoprocessing tools, and Python programming language of GIS (arcPy) for implementing functions and procedures ("split by attribute", "periodic service plane"). Geocoding processing is used for converting students' addresses to spatial location, which is necessary for geo-relational analysis.

Key words: GIS, Educational planning, education geoprocessing.

1. Introduction

From the early beginning of computing, electronic data processing and then information and communication technologies have been used to manage and plan cities.

Smart cities are new and evolving concept based on innovative information and communication technologies (ICT). The cities' growth provides a new dimension in the city management [1]. It aims to turn challenges related with 21st century urbanization into opportunities for efficient and sustainable management and planning of the urban environments [2]. One of the most important resources of modern cities is transportation flow, which directly affected by traffic and vehicles overflow. Multimodal data modeling is fast growing area of research. It may combine the information from the different sources [3]. No one denies that in the modern cities: overflowing, traffic jam, and transportation demand are with large increasing rates.

Thinks and Internet of Thinks (IoT) must be core technologies in smart cities. Therefore, thinks' locations play an important role in geoinformatics. So, thinks' services and maintenance must be managed through digital planes based on: location, time of service (periodic age), and type of service. Location based service (LBS) are service targeted to a wide range of users [4]. The increasing number of LBS will have a bad impact on transitions. In other hand, the advance planning of LBS required, has a positive affect of traffic flow and transportation demand.

While, Education is a service which must be delivered on service's site, it is special type of LBS.

Therefor it is important to determine the road demands for schools and students to satisfy the best performance. That because the roads usage usually burst during schools' transition hours, and the average of rush hours obviously increases in the morning (school starting time) and in the afternoon (school ending time).

One of the objectives of building smart cities is to reduce the traffic congestion and transportation demand, therefor the locations of schools must meet students' distribution. The application of Geographic Information Systems (GIS) could be very helpful in the management of educational services [5].

This paper utilizes GIS and spatial analysis techniques for decision support of LBS. the objective is the advance determination of the best service location for covering services requirement based on three factors: location, time and type of service.

Education is the greatest service required for humanity. It is a service based on: location (distance between education center and students), type of service, and time (age of student). The paper focuses on considering service factors and client requirements by applying a developed GIS platform to inform service provider by the assets required to cover customer needs over periods of time (strategic plane for long period). While 1st stage of primary schools accepts students in age of 6 years, the suggested platform determines schools' plane for 5 years in advance, according to: student location, date of birth, and education type requirement.

Student's data includes an address, which must convert to geographical coordinates (spatial location). That conversion is achieved using Geocoding technology.

1.1. Geographic Information System

Geographic Information System (GIS) is an information system that integrates software elements, hardware elements, and data for analyzing, storing, capturing, and to display geographically related (spatially related) information [6].

GIS is one the technologies that evolves to allow people to solve many geographic problems quickly, effectively and easily with the abilities to make analysis, especially location analysis in combination with traditional database systems [7]. GIS can combine and integrate different types of information to help making better decisions and also provides high quality visualization tools that can improve the understanding and enhance decision making capability w.r.t site identification, valuation and finally selection.

1.2. Geocoding

Geocoding is GIS process that transforms a description of a location such as: an address, or a name of a place to a location on the earth's surface. You can geocode by entering one location description at a time or by providing many of them at once in a table. The resulting locations are output as geographic features with attributes, which can be used for mapping or spatial analysis [8].

User can quickly find various kinds of locations through geocoding. The types of locations that you can search for include points of interest or names from a gazetteer, like mountains, bridges, and stores; coordinates based on latitude and longitude or other reference systems, such as the Military Grid Reference System (MGRS) or the U.S. National Grid system; and addresses, which can come in a variety of styles and formats, including street intersections, house numbers with street names, and postal codes.

2. Related work

Khalid Ahmed Ali, 2018; presented a study aims to develop a primary school site selection model using Geographic Information Systems (GIS) integrated new approach. It was carried out by Geographic Information Systems and multi-criteria evaluation model (MCEM). Different criteria were used to suggest a number of potential primary school sites using a spatial analysis, which is the new school should be away from existing schools and the major roads, a new site should also be reliably flat land and on certain types of land use. The population factor of the age group less than 14 years was included as a factor to choose the suitable location. As a result, the final suitability map indicates that 18% of the study area is suitable for a primary school site, 73% moderately suitable, and 9% of the study area under unsuitable [9].

Yogesh Sharma, 2018; showed the applicability of GIS in education facilities, where each educational unit has easy access to the common database. He presented a system that is constructed for schools in Old Tbilisi District, in Tbilisi, Georgia and different analyses related to education were performed [7].

Faizan Jalal, and Junaid Qadir; 2018; collected appropriate data of Education facilities around Srinagar city using GPS and stored the data into the Geodatabase, which was built to manage them more efficiently. Education facilities was classified into different classes such as: Primary, Primary with upper primary, Secondary, Higher Secondary and Schools operating together. A total of 352 Government Schools were mapped out of them 122 were Primary Schools, 138 primaries with upper primary Schools, 52 were Secondary Schools and 29 were Higher Secondary Schools. During the study it was found 10 Schools were operating together at same place, so their single coordinates have been taken and few of the Schools couldn’t be mapped due to some issues such as non-existence. The study focused on using Geographic information system and integrating with the Education information system to generate a baseline data for the planning, development and preservation of these Education facilities [10].

Nisreen M. Alrawi, 2015, presented a management of education services, it is an application of GIS in provides a great help in facilitating and organizing services. The main objective of the work is to evaluate primary schools in the western neighborhood of Mansoura city according to their spatial distribution, relationships between the number of students, teachers and classrooms. Accordingly, the spatial and descriptive data about primary schools in the studied area were collected, stored, managed and analyzed under the GIS environment. Spatial distribution of the studied features and nearest neighbor analysis, were carried out in that work [5].

3. The Proposed Platform

This section was designed to introduce: prerequisite data base, and the proposed platform in detail as well.

3.1. The Prerequisite Data

Because of the proposed platform is basically depending on GIS, the basic data must be spatial data. The platform database at least consists of spatial data for: service data, and customer data. Service data are schools table, which contains geometric data of schools' location, ID, schools' names, and education type (service type). Customers' data (Students' data) contains: ID, name, service type (education type), date of birth, location (address). The platform uses date of birth to calculate age at 1st October each year which is used as time factor. In the case study of 1st prime students' services, the periodic time is taken as 1 year, which starts at 1st October yearly.

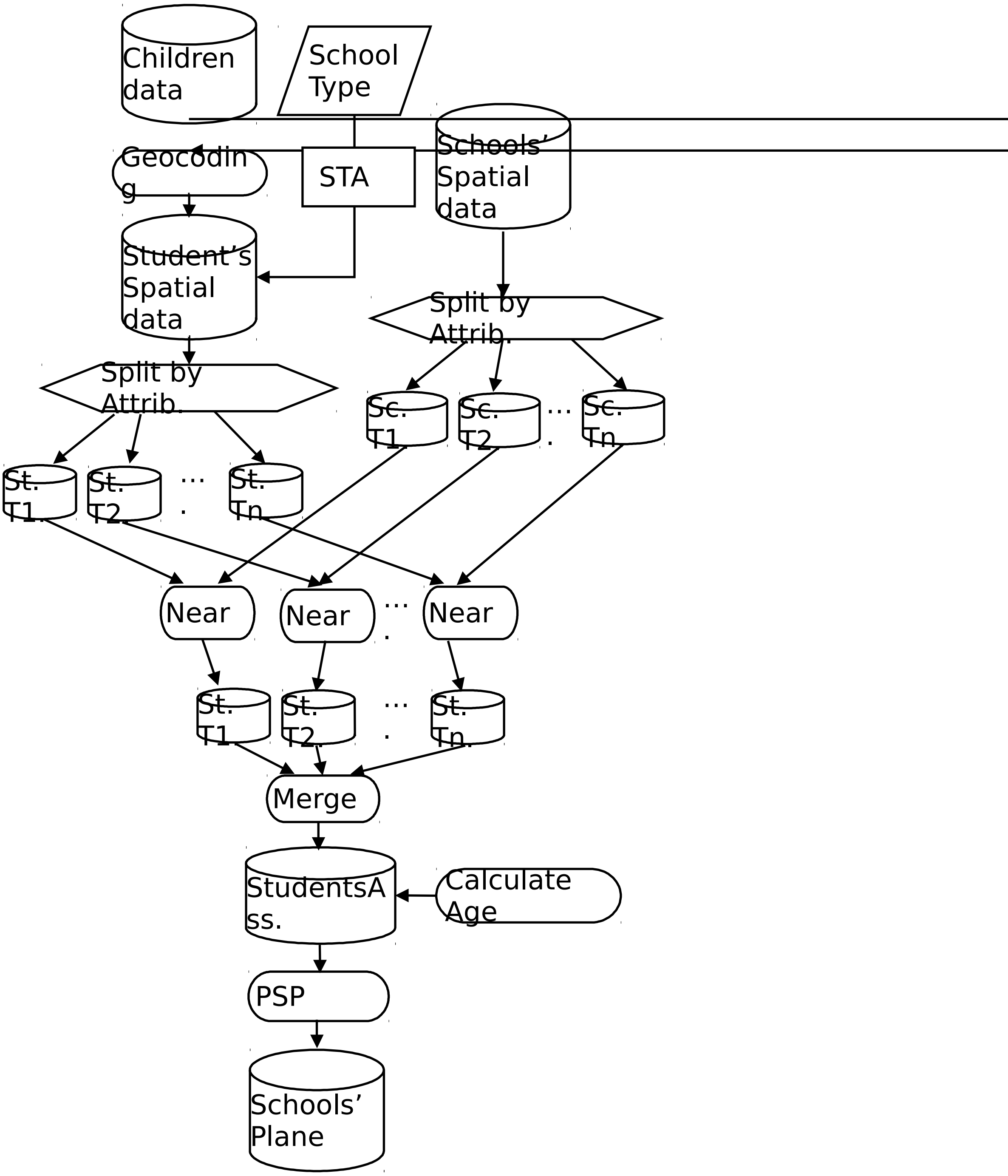

Figure 1: Geoprocessing flowchart.

3.2. Platform's Steps

The processing of platform is based on: "Periodic Time" algorithm, "Split by Attrib" library, and ArcGIS tools (Geocoding, Near, Merge). The algorithm and library were implemented by Python programming language, and ArcPy (Python package for GIS utilities). Figure 1, shows the sequence of geo-processes as:

1. Geocoding process: receives “children data” and produces “Student’s Spatial data”, by reading the address for each student and determines the corresponding geographical location (Latitude, and Longitude) and creates new fields to save the geographical location for each student.
2. Service Type Acquisition (STA): one of the important fields in “Student’s Spatial data” is the “Type”, this field takes values: from 1 to 4, that determine the type of school (public/private) and the curriculum language (local/foreign). The default value is 1 (code of public school, and local language curriculum). The values may be more then 4 if there are more types of educations.
3. Split by Attribute (SBA): a process that reads a table and classifies the records according to “Type” field, then produces each class in a separate new table.

   This tool accepts “Student’s Spatial data” and produces n Students Tables named: “St. T_1”, “St. T_2”, …, “St. T_n” tables. Also produces n Schools Tables “Sc. T_1”, “Sc. T_2”, …, “Sc. T_n” from “Schools’ Spatial data”.

4. Near (Analysis): a geoprocessing tool, that accepts two feature classes (students feature class, and schools feature class), it determines the nearest school in the target Feature “Sc. T_i” to a student in the Input Features “St. T_i”, i=1, 2, …, n; within the Search Radius. Figure 2, shows the results as two additional fields “NEAR_FID”, and “NEAR_DIST. “NEAR_FID” is the ID of the Nearest school to a student, and “NEAR_DIST” is the distance between the Input Features and the Near Features.
5. Merge: a geoprocessing tool, that Combines multiple input datasets (“St. T_i”, i=1, 2, …, n) into a single output dataset “StudentsAss”.
6. Calculate Age: a Python code calculates the age at 1st October of each record in the Input Feature “StudentsAss”, the results are recorded through two new fields: “Month_Oct2019” for months, and “Years_2019”; figure 2, shows “StudentsAss” dataset after processes of: Merge and Calculate Age.
7. Periodic Service Plane (PSP): a Python code uses the Input Feature “StudentsAss” to count the number of students, classifying them with respect to two factors: School ID (“NEAR_FID”), and time (Age at 1st of October “Years”). PSP creates new 5 fields: “StuYi”, i=1, 2, …, 5; for each object in Output Feature “PSchools”, and stores the number of students for each school each year over the next 5 years, figure 3, shows Primary Schools dataset “PSchools” after applying “PSP” code.

StudentsAss

OBJECTID	DOBirth	Months	Years	schoolType	NEAR_FID	NEAR_DIST
10484	13-Mar-15	5	4	1	23	517.137839
10485	07-Apr-16	4	3	1	23	499.806455
10486	22-Feb-16	4	3	1	50	215.806348
10487	18-Aug-18	1	1	2	62	1891.543831
10488	13-Jul-18 1	1	1	2	62	1785.39571

0 (0 out of 19183 Selected)

Figure 2: 5 features of StudentsAss feature class.

PSchools

OBJECTI	Name	5YOld	4YOld	3YOld	2YOld	1YOld	Type	TypeDescription
1	مدرسه المجزر ابتدائي	251	248	219	241	258	1	حكومي عربي
3	مدرسه ابوبكر الصديق	188	180	190	177	180	3	خاص عربي
4	مدرسه احمد لطفي السيد الابتدائيه	275	265	257	252	273	1	حكومي عربي
5	مدرسه الامام محمد عبده التجريبيه النموذجيه	125	100	117	122	123	2	حكومي تجريبي (لغات)
15	مدرسه الزهراء الابتدائيه	111	93	91	91	88	1	حكومي عربي
16	مدرسه الزهراء الاسلاميه للغات	33	27	30	28	24	4	خاص لغات

Figure 3: 6 features of Primary Schools feature class, with students assigned for each.

4. Experimental Design and Analysis

While schools present a service that depend on curriculum type, and students age, the distance between students and schools is an important factor which affected on traffic congestion. So primary school's 1st stage and children younger than 6 years in Mansoura city was taken as case study.

4.1. Study area

El-Mansoura city, Egypt; was selected as a study area. It is located between 31°20'50" E, 31°20'30" N and 31°25'10" E, 31°4'30" N. Mansoura lies on the east bank of the Damietta branch of the Nile, in the Delta region. Mansoura is about 120 km northeast of Cairo [11].

4.2. Case Study's Data Set

The dataset, which was used to apply paper's algorithm consisted of: (1) children database table (19183 records), whose Born January 1, 2014 until the end of December 2018, that database contains: ID, date of birth, address; (2) primary schools' spatial feature class, it is a polygon layer contains 33 features, each feature has attributes of: school ID, name, type of education. Primary schools are categorized into 4 types, as: 18 Arabic governmental schools, 8 public schools for foreign language, 5 private schools for local language and 2 private schools for foreign language. Table 1, shows number of schools for each educational category, and number of students whose chose educational type with the age at 1st October 2019.

Table 1: Schools type, and students categorized by age and education type.

Type	Type description	Schools' number	# Students categorized by Age.					Total
			1 year	2 years	3 years	4 years	5 years	
1	حكومي - منهج عربي	18	2120	2053	2068	2110	2135	10486
2	حكومي تجريبي (لغات)	8	1062	1039	1083	976	1082	5242
3	خاص – منهج عربي	5	546	516	533	506	520	2621

4	خاص – منهج اجنبي	2	162	181	166	155	170	834
Sum		33	3890	3789	3850	3747	3907	19183

4.3. Students’ Spatial Location

While birth data are only attribute data (ID, address), it must be converted into spatial data, which contain the coordinates (Latitude, and Longitude). Geocoding processes is the first geoprocessing operation of the suggested approach. Figure 4, shows spatial data layers of: the output of geocoding operation layer of students’ spatial data, and schools’ polygon layer.

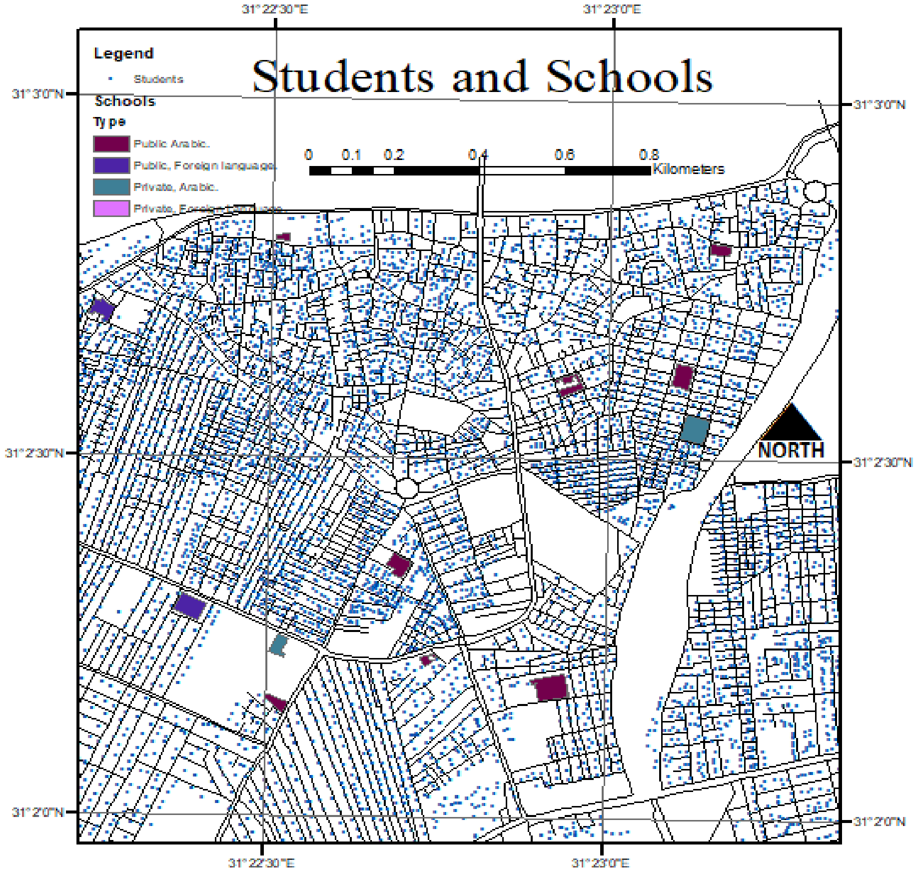

Figure 4: Map of students and schools locations.

5. Experimental Results

The main objective of the suggested algorithm is the effect mainly in two geodatabase classes: service feature class and client feature class. First, adding fields NEAR_FID and NEAR_DIST to client feature class, filling NEAR_FID by the ID of the nearest service’s ID for each client, calculating the distance between client and service and storing the result in NEAR_DIST for each client, as shown in figure 2. Second, calculating the number of clients recorded for a service per period of time (Age), adding periodic fields (like: 5YOld, 4YOld, …, 1YOld), and filling the calculated number for each service in the corresponding field, as shown in figure 3.

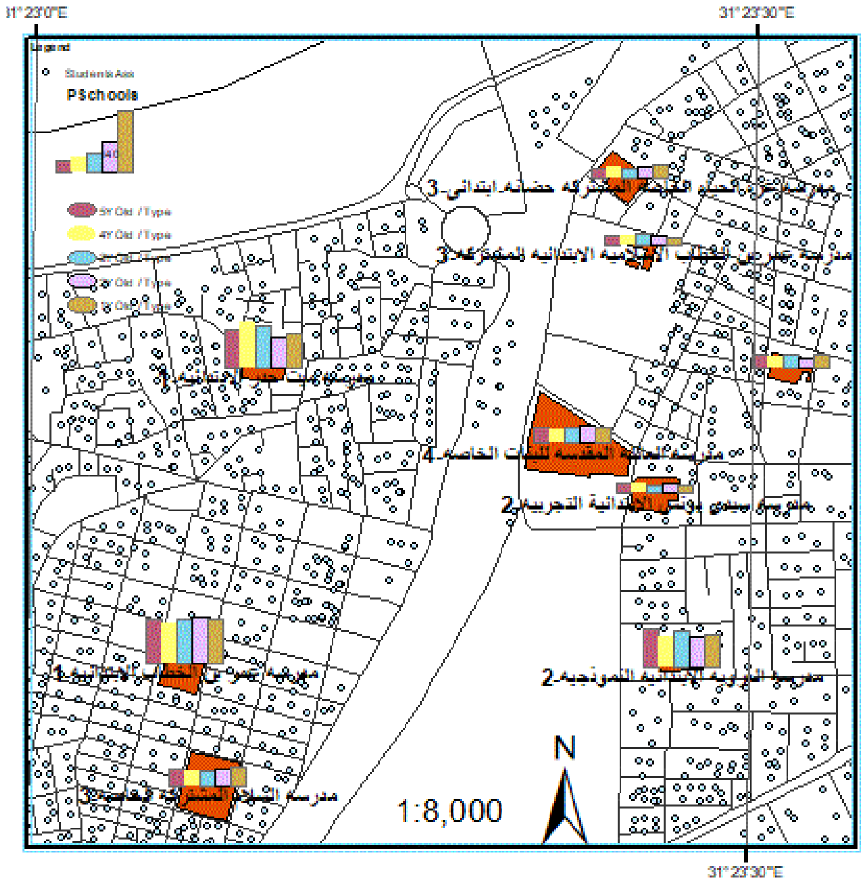

Figure 5: Geo-statistics chart of 5 years plane of schools capacity.

Figure 5, shows a geostatistical result of school's capacity expectation of 1st grade over advanced 5 years. Which is utilized for creating 5 years plane by determining the number of classes, and the capacity of a class for each school.

The geostatistical processes of distances between students and the assigned schools are applied in two cases: taking the education type as factor of assigning, and suggest all schools have same education type. In case of similar education, figure 6, shows the statistical results, which shows average = 401 meter.

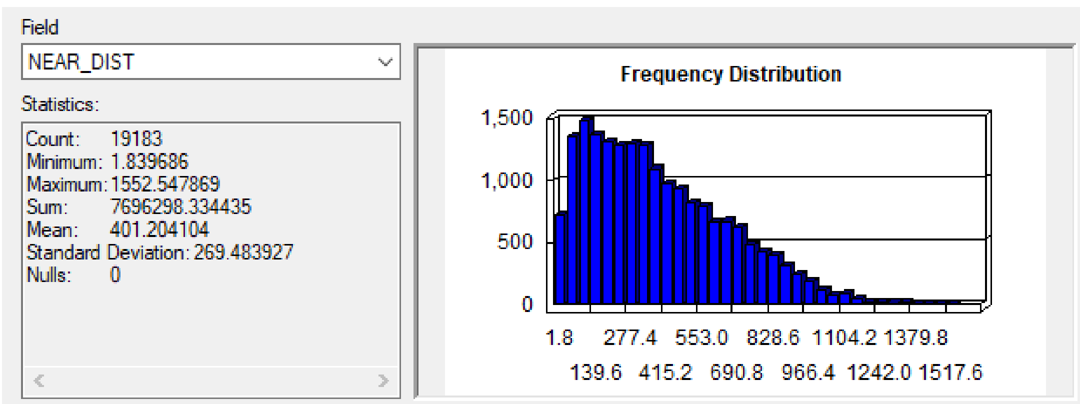

Figure 6: Statistical result of distances, in case of similar education type (NoType).

Table 2, shows the statistical results of measuring distances between schools and students for all students over all 5 years (Age in not taken as factor of statistics).

Table 2: Statistical results of distances between students and schools.

Education type.	Similar Type	Type 1	Type 2	Type 3	Type 4
Total number of students.	19183	10486	5242	2621	834
Maximum distance (meters).	1552.55	1676.03	3185.39	2891.15	3720.35
Average of distance (meters).	401.20	470.43	825.57	970.03	1641.51
SD (meters).	269.48	314.99	596.37	578.28	931.87

The variation of distances is raised among different type of education required. That because geographic distribution of schools is not proportional to students' geographical distribution.

6. Conclusion and Future Work

This paper presented a GIS-based platform for managing the geo-relation between customer and service over three factors: location, type of service, and time of service. Which produces a strategic service plane in advance for periods of time. The platform was is applied on Mansoura city's children and assigned the geographical nearest primary school for each child. That assignment was taken based on three factors: child's birthdate, geographic location, and education type requirement. Primary schools utilize the assigned data for planning the requirements in advance over periods (5 years). Technically, the analysis of the introduced results indicates the success of the proposed platform. In other view, the application of that platform will affect positively of reducing traffic problems and transportation demands, which are needed for smart cities. The presented platform may be classified as "Educational Geoprocessing".

Future research points will be considered as: implement the proposed approach in a large-scale city with a huge number of children, and determine schools' location proportional to birth density.

References

1. Nikolova, M., "**Spatial Information and GIS for Smart City**" in Conference for E-Democracy and Open Government, may. 2014, pp. 585.

2. N. Stephenne, et al., "**SUSTAINABLE AND SMART CITY PLANNING USING SPATIAL DATA IN WALLONIA**", ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume IV-4/W1, 2016 1st International Conference on Smart Data and Smart Cities, 30th UDMS, Split, Croatia, 7–9 September 2016.

3. Pitam Singh, et al; "**Multimodal data modeling for efficiency assessment of social priority based urban bus route transportation system using GIS and data envelopment analysis**", Springer Science + Business Media, part of Springer Nature 2018, June 2018.

4. Bin Jiang, and Xiaobai Yao, "**Location-based services and GIS in perspective**"; Computers, Environment and Urban Systems; ELSEVIER; pp: 712-725, 30 (2006).

5. Nisreen M. Alrawi et al, "**A proposed Decision Support System for Managing Educational Human Resources Based on GIS**", International Journal of Advanced Research in Computer Science & Technology (IJARCST), Vol. 3, Issue 4, ISSN: 2347-8446 (Online), Dec. 2015.

6. IGI Global (1988), "What is Geographic Information System (GIS)"; http://www.igi-global.com/dictionary/geographic-information-system-gis/12113, visited at: 12th Mar, 2019.

7. Yogesh Sharma, "**Application of Geographic Information System (GIS) in Education**", International Journal of Advanced Multidisciplinary Scientific Research (IJAMSR) Volume 1, Issue 1 , pp: 23-27, February 2018.

8. ArcGIS 10.2.2's Help, "What is geocoding?".

9. Khalid Ahmed Ali, "Multi-Criteria Decision Analysis for Primary School Site Selection in Al-Mahaweel district Using GIS Technique", Journal University of Kerbala , Vol. 16 No.1, 2018.

10. Faizan Jalal, Junaid Qadir; "Using Geographical Information System for Developing Education Information System: A Case Study of Srinagar City, Jammu & Kashmir, India", International Journal of Advanced Remote Sensing and GIS (IJARSG), Volume 7, Issue 1, pp. 2656-2667 ISSN 2320 – 0243, 2018.

11. https://en.wikipedia.org/wiki/Mansoura,_Egypt; 15 Mar 2019, 3:00pm.

12. https://mapcruzin.com/free-egypt-country-city-place-gis-shapefiles.htm; 10 Feb 2019, 4:30am.