URISA ESIG Single Process System Application
May 2019
By Chelsie McNicol

City of San Antonio
Solid Waste Management Department
Contents

A. System .................................................................................................................................................................................. 3
   1. Name of System and ESIG™ Category ...................................................................................................................................... 3
   2. Letter from the Executive Administrator ....................................................................................................................... 3
   3. System Summary ................................................................................................................................................................. 3
   4. User Testimonials .............................................................................................................................................................. 4

B. Jurisdiction ........................................................................................................................................................................... 6
   1. Name of Jurisdiction .............................................................................................................................................................. 6
   2. Population Served by the Organization/Agency .................................................................................................................. 6
   3. Annual Total Budget for Jurisdiction .................................................................................................................................. 6
   4. Chief Elected Official ............................................................................................................................................................ 6
   5. Contact Person for System .................................................................................................................................................. 6

C. System Design ..................................................................................................................................................................... 6
   1. Motivation for System Development ...................................................................................................................................... 6
   2. Services Improved .................................................................................................................................................................. 7
   3. Unexpected Benefits ............................................................................................................................................................. 7
   4. Design Problems ................................................................................................................................................................. 7
   5. What Makes the System Exemplary ........................................................................................................................................ 8

D. Implementation ...................................................................................................................................................................... 9
   1. Project Phases ...................................................................................................................................................................... 9
   2. Modifications to the Original System Design .......................................................................................................................... 10

E. Organizational Impact ............................................................................................................................................................ 10
   1. User Community ............................................................................................................................................................... 10
   2. Decisions/Operations/Services Being Affected ...................................................................................................................... 11
   3. Quantitative and Qualitative Impacts ....................................................................................................................................... 12
   4. Effect on Productivity .......................................................................................................................................................... 13
   5. Other Impacts ................................................................................................................................................................... 13
   6. Improving Business and Services Delivered ................................................................................................................................. 13

F. System Resources ................................................................................................................................................................. 14
   1. Hardware Components .......................................................................................................................................................... 14
   2. Software Components ......................................................................................................................................................... 14
   3. System Data ........................................................................................................................................................................ 14
   4. Staff Resources ..................................................................................................................................................................... 14
   5. Use of Resources ................................................................................................................................................................. 15
A. System

1. Name of System and ESIG™ Category

Single Process System: The City of San Antonio Solid Waste Management Department Service District and Route Optimization System

2. Letter from the Executive Administrator

Please see attached at end of document.

3. System Summary

Rapid population growth posed a challenge for residential waste, recycling and organics collection services in San Antonio, TX. The city grew at a rate of 1.6% between 2016 and 2017, pushing the total population above 1.5 million residents. As the 7th largest city in the United States, the City of San Antonio Solid Waste Management Department (SWMD or the “Department”) required a prompt response to the continuous addition of new customers to its residential collection programs. Ten years ago, the Department provided approximately 337,000 households with weekly collection of garbage in a 96-gallon cart and recycling in an 18-gallon bin. Today, over 357,000 households receive garbage collection with the option of a 96, 64, or 48 gallon cart, and recycling and organics collection in 96 or 48 gallon carts. With over 1 million collections per week, an operation of such scale requires coordinated efforts of numerous personnel and fleet assets to ensure that services are provided efficiently and effectively across four geographic districts, which the Department refers to as service districts. The Department consistently evaluates ways to enhance the delivery of its services to meet the evolving needs of our growing city.

Service districts and route boundaries have stayed static since recycling collections transitioned from manual to automated almost ten years ago, with only occasional and minor revisions to collection routes at the service district level. Over time, routes became imbalanced as population density swelled across the city, which led to disproportionate driver workloads, an increase in personnel overtime costs, and missed pickups that negatively affected daily operations and customer satisfaction.

The Department’s Planning and Innovation Division (Planning) was tasked with developing a system to optimize service district operations based on cost, resource allocation, and household equalization.
The process involved a complete evaluation of the service district operations and routes as well as providing an adaptable platform for any future changes, ensuring the Department continues to provide efficient and sustainable services to its customer base while saving time and money.

By using ArcMap analysis tools and automated SQL scripting, Planning created on-demand reporting of any service district and route scenario that included financial and performance metrics. Routes could now be assessed at any point in time to ensure they are designed to provide maximum efficiency in collections. Similar routing applications from third-party companies are often complex and expensive. The ability to design and maintain a robust analytics system in-house is a valuable tool that will accommodate changes in the Department’s waste collection services for years to come.

4. User Testimonials

“The Department has needed new service district and route boundaries for years. The challenges faced as the city has grown and during the expansion of our services to include Organics collection was confirmation that the Department needed a solution and fast. I am amazed that the Planning and Innovation Division was able to develop such a reliable, data-driven product as a response in a relatively short period of time. Ultimately the results from the solution will offer cost savings to the Department and increase operational efficiency. The Service District and Route Optimization system is proof of the power GIS has in guiding our Department’s growth.”

Nicholas S. Galus, Assistant Director
City of San Antonio Solid Waste Management Department
“The system was extremely useful as a guide for my service district while revamping our route boundaries. Feedback reports helped pinpoint critical areas needing adjustment in order to develop routes that can better manage customer growth in the future. Route balancing was not an easy task, but the system made it much smoother, and I am excited to see the results in action.”

Alfonso Castillo, Solid Waste Manager
City of San Antonio Solid Waste Management Department

“I was greatly impressed by the Service District and Route Optimization system and its ability to simplify an intricate process. The system was key to understanding where resources were needed in my service district and how to create a more adaptable route design. We will use it to track progress with our new routes and continually improve the way we do business. It has given me a greater appreciation for GIS and how it helps our Department in making informed decisions about solid waste and recycling.”

Anthony V. Salazar, Solid Waste Manager
City of San Antonio Solid Waste Management Department
B. Jurisdiction

1. Name of Jurisdiction

City of San Antonio, Texas

2. Population Served by the Organization/Agency

1,511,946 (US Census Bureau July 1, 2017 Estimate)
357,397 (Solid Waste Customer Count March 2019)

3. Annual Total Budget for Jurisdiction

FY 2019 City of San Antonio Adopted Budget: $2.8B
FY 2019 Solid Waste Management Department Operating Budget: $145M

4. Chief Elected Official

Mayor Ron Nirenberg
P.O. Box 839966
San Antonio, TX 78283

5. Contact Person for System

Attn: SWMD Planning Team
c/o Chelsie McNicol
4335 Piedras Dr. West Ste. 200
San Antonio, TX 78228
(210) 207-6524
chelsie.mcnicol@sanantonio.gov

C. System Design

1. Motivation for System Development

For several years, the Solid Waste Management Department adjusted recycling and garbage collection routes on an as-needed basis to address peak waste collection periods and standardize employee work schedules. Without an equalized route layout, some SWMD routes would routinely complete their work early, while others
required working late (including overtime hours). Later in 2016, the implementation of an organics collection program exacerbated the existing challenges by adding dozens of new routes - some that required updates several times a day - that were often affected by seasonality throughout the year. As a result, in FY 2018 the Department spent millions of dollars in overtime wages to compensate for the uneven distribution of drivers to customers. Equipment costs also increased due to the outdated route boundaries, which increased travel time as collection workers traversed roads that were increasingly congested. Additionally, average maintenance and repair expense per collection vehicle rose over 20% in the past ten years. Poor navigation, increased mileage and extended hours on the road resulted in more vehicle wear and tear. A route could no longer be serviced with outdated methodology without incurring high expense. The Department recognized the need to rework its route grid based on these significant factors.

2. Services Improved

The system was intended to improve weekly collection services for all three of the Department’s waste streams: garbage, recycling, and organics. With approximately 1.5 million collection opportunities per month, precision and increased productivity were vital. The priority was on normalizing work hours for employees and redistributing customer routes to better adapt to geographical residential expansion. It was also intended to help with the process of phasing out the Department’s current Wednesday and Saturday (overtime) collection routes and integrate into a Monday, Tuesday, Thursday, and Friday collection schedule.

3. Unexpected Benefits

The routing methodology was recently used in feasibility studies to help generate pricing scenarios for waste tonnage diversion to plan for future operations. It has helped the Department plan for future expansion of programs, facilities, and newly annexed areas.

4. Design Problems

The size of the customer dataset became an issue in terms of processing time, primarily within ArcMap. Over 357,000 customer points would frequently cause slow performance in ArcMap when attempting to run time/distance analyses using Network Analyst extension. Simplification of the dataset was necessary to reduce lag time between scenarios. To make the large geographic area more manageable, the Department’s service area was overlaid with an equidistant point grid totaling 1,869 points once clipped to the service boundary. Each point was associated with
individual operational data that allowed for analysis on a more functional, granular level (see Figure 1).

5. What Makes the System Exemplary

Many municipal solid waste route optimization solutions today focus on utilizing a mathematical approach or a more GIS-focused approach with heavy attention on the transportation aspect of solid waste collection. While reduction in mileage driven and equipment costs are critical components to route optimization, the solution produced by the Department is more detailed and multifaceted in that it considers equipment and personnel costs for routing alongside disposal cost, tonnage, and household distribution. These components work directly with a robust internal database that tracks every waste disposal ticket processed by the Department, creating valuable metrics that feed into the decision-making process. The system can then compare data with any combination of metric information from any point in time, creating the ability to understand trends and better predict the future of

Example: Route NEMAG-02
- 1506 Houses in Route
- 45 Grid Points in Route
- 33.47 Houses Per Point
- Avg. Route Tons: 20.39
- Tons Per Point: 0.489
- Route Completion Hours: 7.94 Hrs.
- Point Completion Time: 0.136 Hrs.

Figure 1: Example illustration of point grid overlay
routing for San Antonio. It was designed to be, and functions as, a more holistic approach to analyzing efficient and effective solid waste services.

D. Implementation

1. Project Phases

Phase one focused on structuring the service districts to ensure the total number of households were properly distributed across San Antonio’s solid waste service area. Using ArcMap’s Network Analyst, the service area point grid generated a time/distance study based on distance of each point to potential disposal sites and service district operating centers across the City. A mathematical equation was developed to be used in conjunction with the time/distance study that calculated the total cost incurred to service each grid point. The equation was automated using Microsoft SQL to assign each point in the grid to a combination of service district and disposal site location based on the lowest annual cost, among other factors. Over (40) configurations were explored until a final service district layout was chosen that was adjusted along major highway corridors while still ensuring a reduction in annual cost. All options were archived to view as individual reports using SQL Server Reporting Services (SSRS) which included annual cost and tonnage dispersion.

Phase two allocated equipment and personnel based on the results of the service district analysis. Resulting personnel costs were used to calculate the annual work hours expected per service district inclusive of traffic time. Automated side-load trucks and equipment operators were allotted to the various service districts using these results while ensuring a 20 percent buffer of extra resources (per service district). Manual rear-load trucks and drivers were allotted based on the house count totals in each new service district.

In phase three, the service district and resource allocation results were sent to the district centers to design the routes within their service area. During the design process, Planning created an analysis tool to rate routes based on their total completion time. Automated reports summarized the results and conveyed feedback to the district centers, which then made adjustments to route boundaries per the results (see Figure 2). This ensured that routes were balanced for an efficient work schedule. The new service district and routes are due to be implemented city-wide in August 2019.
2. Modifications to the Original System Design

The first iteration of this system was designed to use only three months of waste ticket data, as the tracking database had been developed only shortly before the service district and routing solution was produced. However, three months of data was not sufficient as an indicator of typical operations so a secondary version of the system was updated to include a full year’s worth of waste ticket data once the information was available.

E. Organizational Impact

1. User Community

The system serves the Department administrative and operations staff as a consulting tool for future maintenance of service district and route boundaries. Staff is able to use the tool to advise different approaches to routing challenges and better meet the needs of residents.
2. Decisions/Operations/Services Being Affected

Daily operations for waste collection are ultimately affected by the system. The Department believes operational performance will be improved as daily processes align with the new route requirements. With properly allocated resources, service districts will now have the equipment and staff to manage change and growth in their areas more quickly and efficiently.

The City of San Antonio's residents will also be impacted and will directly experience the benefits of improved waste collection services through optimized routing. Over 100,000 households will experience a change in service day and others a change in commodity for their service day. A comparison of the previous service district layout and the new district layout created using the system is displayed in Figure 3.

*Figure 3: Previous service districts vs. new service districts*
An example of service day changes in Figure 4 also shows how the system streamlined routes geographically, making them easier to track and manage by the service districts. Gaps caused by previously excluding areas with no collection service within district boundaries were filled and made geographically contiguous for consistency.

3. Quantitative and Qualitative Impacts

Total cost savings is estimated to be over $1 million annually by utilizing the updated service district layout. This is due to a reduction in overtime, equipment costs associated with travel time and distance, as well as waste disposal costs. Data is now integrated into a single platform that is accurate, reliable, and easily accessible. Program and policy decisions are better informed, allowing the Department to plan for expansion of its services and provide support to the...
community with greater equity and accountability. The system is a versatile and valuable product that will continue to save the City of San Antonio time and resources as well as shape how GIS is used in future projects.

4. Effect on Productivity

The new service district and route boundaries are expected to increase driver productivity by balancing workloads and work days. With routes tailored to a 7-9 hour completion time within a 10 hour work day and the elimination of Wednesday and Saturday routes, it is estimated the need for regular overtime hours will decrease. Employee retention and morale is anticipated to improve with a more uniform work schedule. With resources effectively distributed and an updated route structure, district centers and their staff will be more equipped to service residents in a timely manner, reducing the rate of missed pickups. Administrative staff will have more time to focus on managing regular operations and less on compensating for constant staffing and routing deficiencies.

5. Other Impacts

The system made GIS tools more accessible to operations staff who were not regularly utilizing it before. Interacting with the system allows more staff to be trained in GIS and use related software. This helps to establish teams of subject-matter experts at the service districts who provide continued support and collaboration for their divisions.

6. Improving Business and Services Delivered

Previously, service district staff would use monthly averages from waste ticket data to determine the efficiency of a route. The process – which was time consuming and manpower heavy- was manually completed with multiple Excel spreadsheets and often required estimation of data since a compiled database of waste ticket data did not yet exist. Since the process is now automated and easily maintained, performance reports are generated within a fraction of the time and have more reliable information than before.

Making changes to routes was also a manual and time-consuming process that often utilized temporary paper maps to alleviate critical issues. The system built a framework that is able to recommend long-term solutions instead of short-term, temporary fixes to problems. Since the system is backed by trusted data, operations staff no longer have to estimate where route adjustments need to be made and can fine tune their route boundaries faster and with greater precision.
F. System Resources

1. Hardware Components

- One computer that hosts the SQL database and reporting server
- One computer running ArcMap for all GIS analysis

2. Software Components

- ArcMap 10.3.1 with Network Analyst extension
- Microsoft SQL Server Express 2015
- Microsoft SQL Server Management Studio 2017
- Microsoft Visual Studio 2015
- Google Maps

3. System Data

The primary SQL database hosts the following information:
- Daily waste ticket data, consisting of over 100,000 tickets from three waste streams serviced (garbage, recycling, organics) and spanning an 18-month time frame as of May 2019
- Tables with distance/time study results from ArcMap for reference
- Tables with cost results for each generated redistricting scenario
- Tables with cost results for each generated rerouting scenario
- Other miscellaneous supporting reference tables

GIS files were also utilized from the City's Information Technology Services Department's Enterprise geodatabase, which includes historical service district and route boundary files.

4. Staff Resources

Henrique de Azevedo, Project Manager, City of San Antonio: 0.5 FTE
Chelsie McNicol, Management Analyst, City of San Antonio: 0.5 FTE
5. Use of Resources

The fact that a complex system was designed and built solely within the Department using internal resources, and with no use of external consulting, is noteworthy. The use of two staff members to complete the system is also a testament to the skill level of the team involved. The Department knew how valuable and important the system is to helping with both short and long term problems, and it was a department wide team effort across multiple teams and leadership to complete the project within the proposed timeline and utilizing the available resources. We are very proud of our work and hope to share our success with other cities who may also benefit from an approach similar to ours.
May 21, 2019

URISA ESIG Award Committee
701 Lee Street, Suite 680
Des Plaines, IL 60016

RE: Authorization of Submission for the URISA Exemplary Systems in Government Award

To whom it may concern,

On behalf of the City of San Antonio Solid Waste Management Department (the “Department”), I am pleased to authorize and support the following submission for consideration in the Single Process System Category of the 2019 URISA Exemplary Systems in Government Award.

We take great pride in providing weekly collection of recyclables, organics, and garbage to over 357,000 homes across San Antonio, TX. We continually look for ways to improve how we conduct business in order to ensure our programs to residents are effective and efficient. As you will see in our submission, we recently analyzed our current service districts and recycling, organics, and garbage routes to understand how well our operation was performing. Our findings showed the service districts and driver routes were over 10 years old, no longer optimally efficient, and were unnecessarily expensive to maintain. The Service District and Route Optimization system created by our Department employees is an outstanding example of innovation using GIS to develop a sustainable district and route solution for our Department. The results will greatly improve the delivery of waste and recycle collection services to residents of San Antonio for years to come.

We appreciate the opportunity and thank you for your consideration.

Sincerely,

David W. McGary, CPM, MPA, Director
Solid Waste Management Department

4410 West Piedras Drive, San Antonio, TX 78228