



# ENVIRONMENTAL MANAGEMENT SYSTEMS

**Effectiveness for Public Transit Agencies  
*with the Federal Transit Administration***

Columbia University  
Master of Science in Sustainability Management Program  
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## Executive Summary

The Federal Transit Administration (FTA) requested a qualitative and quantitative analysis of the effectiveness of its Environmental Management System (EMS) training program. The FTA is a federal agency responsible for providing financial and technical assistance to public transit systems across the United States. Its EMS training program is a strategic tool that allows the agency to provide measured and repeatable guidance to local transit organizations nationwide such that they can improve their economic, environmental, and social performance over time.

This report follows a thorough investigation into the effectiveness of the FTA's EMS training program and highlights its value to taxpayers. What is clear from the research and analysis conducted is that U.S. public transit agencies continue to face challenges in seeking environmental and economic efficiency and that these challenges are alleviated by the training program. The EMS training program provides a clear value to its participants and has broad implications for the value of strategic environmental management for all transit agencies moving forward.

## Background

For this project, a group of master's degree candidates at Columbia University collected and analyzed data on the FTA's Environmental Management System (EMS) training program. To this end, past participants in the training program were contacted to determine the impacts that the training had on their operations and the positive value an EMS has brought to the agencies. The students conducted this research and analysis as part of their Capstone Project for the M.S. in Sustainability Management program, at Columbia University in the City of New York. Conversations with Antoinette Quagliata, the project's key client and an Environmental Protection Specialist at the FTA guided the students' work, allowing them to determine which aspects of the training program were valuable for the FTA as well as local public transit agencies across the country.

An agency within the U.S. Department of Transportation, the FTA supplies local transit agencies with assistance across a range of program areas. The scope of this analysis is on the assistance the FTA has provided – and continues to provide – to local transit agencies through the EMS training program.

### *Overview of the FTA's Training Program*

In the fall of 2003, the FTA initiated its EMS assistance program to help certain transit agencies develop and implement an EMS, using standard ISO 14001 (<http://www.iso.org/>). Over more than 10 years and three training rounds, each of which featured different public transit agencies, the FTA has trained 27 transit agencies to help them kick-start their EMS. Round 3 of the EMS program was completed in September 2012. Round 4 is currently underway. The first three rounds of training are within the scope of this analysis.

Training was provided by the Center for Organizational and Technological Advancement (COTA) at Virginia Polytechnic Institute and State University (Virginia Tech) and tailored to the individual agency's needs. Participants in the program receive assistance in the form of training workshops, on-site technical support visits, electronic materials and resources, and access to consultation. The FTA and Virginia Tech structured the program to address the specific environmental requirements of transit agencies, with the intention of ultimately developing a template for the continued EMS training of similar agencies across America.

### *Project Context*

The EMS is a system of procedures and processes for training personnel and measuring and reporting environmental performance, based on the International Organization for Standardization (ISO) 14001 protocol. The FTA, which has embraced EMS as a tool for socially and environmentally improving mass transit, has provided the EMS technical assistance program in order to help transit agencies become more sustainable.

As a primer to this investigation, it is helpful to outline clear examples of an EMS at work. The two largest cities in the U.S., New York and Los Angeles, have established Environmental Management Systems and have had great success with ISO 14001 certification. That certification seems to be the best model on which to base an EMS because it is internationally recognized, stringent and covers a broad range of environmental issues. Many of the successful trainees included in this research also obtained ISO certification, including Sound Transit in Washington, Sun Tran in Arizona, LA Metro in California and the Utah Transit Authority. The impact of that certification will be further outlined in this report.

As part of the analysis, the team focused on the metrics each participating agency prioritized in their EMS, such as whether the agency went on to receive ISO 14001 certification or the financial and environmental benefits of their EMS. Some strategic trends began to emerge as the data were examined.

The results featured within this report do not encompass data from all agencies that completed the training program due to inaccessibility to necessary information and an inability to otherwise connect with past participants in the four-month research period allocated for this analysis. Absent some of that data, the team sought to provide a tool and method of data collection that could be replicated and expanded upon for continued and future agency analyses.

## Methodology

In order to provide a thorough analysis of post training performance, extensive data collection efforts were undertaken. This involved several steps. Agencies were contacted by phone and email and for those agencies that responded, our team inquired about the status of the EMS, environmental initiatives, financial savings, operations and environmental performance. In addition, a success rubric was created both to measure each agency's performance, and to compare that to various characteristics, such as ridership and region. Data from Final Round Reports, published by the FTA, was also analyzed. A strategic approach was then used to analyze the data through both quantitative and qualitative means. The project was unique in that it required participation by the individual agencies to truly determine the value instilled within that agency. As such, a large portion of time was spent on primary research in an effort to reach as many agencies as possible within the time frame of the project.

The methodology for research, analysis, and evaluation consisted of four key steps:

1. Conduct a detailed analysis of each participating transit agency in the first three rounds of the training program
2. Conduct participant interviews and gather related information about the impact of EMS training, ISO certification (where applicable), and the EMS itself on each agency
3. Create a rubric for measuring and reporting on agency success
4. Analyze all data gathered against the success rubric
5. Make recommendations to the FTA regarding its EMS training program

### *EMS Training Round Reports*

The Final Round Reports from the first three rounds of training contain contextual information about the agencies during their training and their final score received based on an audit using ISO 14001 guidelines. From this the team was able to ascertain the original fence lines and specific objectives taken on by the agencies, along with any projected initiatives for future EMS expansion. The reports served as a baseline for the team's forthcoming analysis.

### *Interviews and Data Gathering*

Primary research was conducted through phone calls, emails and interviews. At least one person that participated in the first three rounds of the EMS training program was contacted. Of the approximately 35 persons attempted to be reached, less than fifteen were available to comment. This represented only 5 agencies from the first round, 4 from the second round and 4 from the third round. The goal was to develop an understanding of the agency's EMS and related operations. The guide that informed the team's questions is included as Appendix D.

While attempts to conduct primary research were consistent and strategically structured, only around 50 percent (13 out of 27) of participants ultimately responded. Of those agency contacts with whom the team did connect, many reported positive experiences with the EMS training program, as well as significant and positive environmental impacts to report.

In an effort to supplement information received through interviews the team conducted internet research to find any relevant publicly available information such as sustainability reports, fact sheets, or other sustainable or environmental information available on the web. This Information, if available, was taken into consideration as an additional success factor.

### *Success Rubric and Agency Characteristics*

Based on the information collected, the team developed a success rubric to assess how well the agency performed after the EMS training. The rubric was designed based on nine categories, which we determined represented an agency's success through the program. Each category was rated 1-10 and multiplied by the weights listed below. Weights were apportioned based on how well the measure reflected on the FTA's EMS training program. For example, strongest weights were given to financial savings, improved environmental performance and the extent to which the EMS was actually maintained.

To rate the agency on each category, performance was considered as compared to pre-training circumstances, and to other responding agencies. For financial savings, metrics such as Return on Operating Budget and Return on Investment were used as nominal savings would unfairly favor larger agencies. While most categories were rated on a continuous scale, a few were rated with a multi-tiered system, such as Sustainability Report. Here the agency received a 3 for "some material available on website," a 5 for extensive materials and a 10 for a full sustainability report.

Each responding agency was rated based on the following rubric criteria and corresponding weights:

- Financial Savings: 25%
- Improved Environmental Performance: 20%
- EMS Maintained: 15%
- Sustainability Initiatives (Number & Diversity): 10%
- Sustainability Report: 10%
- Pursuing ISO Certification: 8%
- Lowered Environmental Risk: 5%
- Number of Employees Involved with EMS: 5%
- Increased Fence Line: 2%

Finally, once the success metrics were completed, we compared the post training success of each agency to a host of characteristics. The goal was to determine if any type of agency, such as those with larger ridership, responded more favorably to the EMS training than others. This allowed our team to make a myriad of comparisons to determine the importance of agency characteristics. The characteristics which were analyzed against success are as follows:

- Weekday Ridership
- Annual Operating Budget
- Rail or Bus
- Population of metropolitan area
- Geographic Region
- Number of Employees

## Financial Analysis

A comprehensive financial analysis complemented the analyses outlined above, including a partial cost-benefit analysis (CBA) of the participating agencies' EMS initiatives. The analysis looked at results of the training program and utilized an ex-post CBA whereby the team collected all available data regarding the cost and benefits following their training that were related to EMS and sustainability initiatives. External costs, such as the social cost of carbon or depletion of freshwater reserves, were not considered as part of the CBA due to inconsistent availability of data.

The team reviewed each transit agency's annual reports, sustainability reports, operating and capital budgets along with any additional material considered relevant for the study. It is worth noting that the team examined the time periods starting with the periods just prior to agencies' participation in the training through a few years after in order to assess both the quantitative and qualitative changes that took place in terms of an agency's approach towards environmental management systems and whether they embraced the initiatives learned during EMS training.

The review included each agency's metropolitan statistical area (MSA) size, its daily ridership, the investment made in their EMS program and the related annual benefits or cost savings each year. The team then examined the annual operating budget and capital budget in order to assess the annual savings at the agency relative to the operating expenditures to determine the level of savings from the EMS initiatives relative to their annual operating expenditures. While the team reviewed capital budgets, what was more meaningful was a comparison to the savings from each agency relative to their operating expenditures to better a more sustainable return on annual operating budget given the capital budget can more volatile year-to-year.

### Case Study | Finding Success with EMS: Los Angeles Metro

Los Angeles County Metropolitan Transportation Authority (LA Metro) participated in the EMS training program and has since found success with its EMS program. Not only was LA Metro rated as the most successful agency based on its continued success following the FTA training program, but LA Metro is one of the largest local transit organizations in the country. Today, it serves as an example for new participants in the EMS training program.

The agency's success underscores the significance of personnel involved in the management of the EMS and its execution. Cris Liban, Metro Deputy Executive Officer of Environmental Compliance Services, brought to his role on LA Metro's EMS team experience with EMS programs in the Los Angeles area. His background knowledge of the benefits of an EMS to an organization, as well as how to disseminate relevant information to colleagues as a means of gathering and establishing support, has helped create an organizational culture in which the EMS has a lasting impact.

Today, the EMS is at the core of LA Metro's sustainability strategy, and allows agency leaders to manage their environmental and financial data while monitoring the success of resource efficiency initiatives. For example, using the structure and management capacity of the EMS, LA Metro has reduced its use of water in washing buses, leading to a reduction of 10 million gallons of water used in 2011 versus in 2008. Those environmental savings led to economic savings of \$400,000 annually.

To communicate the effectiveness of the agency's ambitious environmental initiatives, LA Metro produces high-quality sustainability reports on an annual basis. Those reports include updates on air pollutants, water and energy use, waste and recycling operations, operating expenses, and other issues that are material to a major transit organization.

# Results

The nature of research and analysis conducted was largely set by the scope of work framing the team’s project. Through several group discussions and contact with the FTA, the team determined what data to use that would become most relevant for determining success through the training program.

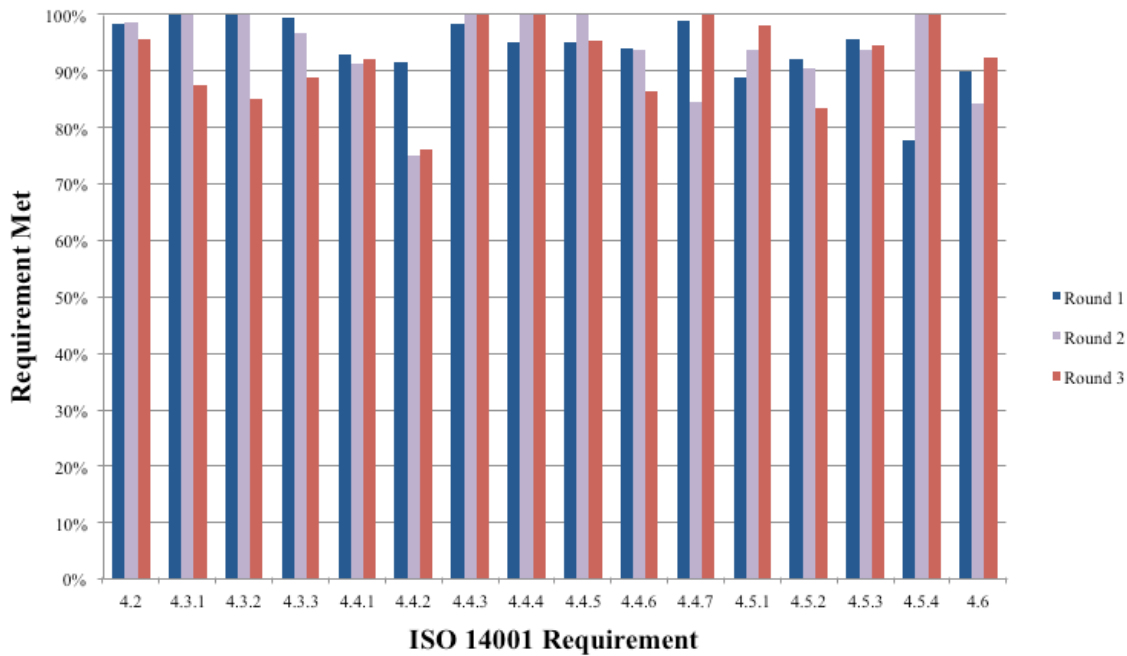
Initial data collected through the EMS Final Round Reports were analyzed to determine a baseline and pull out any definitive factors important to success. Agency characteristics were then compared against the success rubric to ascertain any positive correlations or relationships. All analyses were completed in an effort to relate specific factors to the successful continuation of the EMS program or determine causation to the contrary.

## ISO 14001 Audit results

Scores from the ISO 14001: 2004 standard are included in the FTA Round Reports. Each requirement is represented as an overall score composed from the percentages of requirements met, partially met, and not met. Figure 1 below represents the percentage completion of each requirement in the standard broken up by round. These results were analyze, to see if they could inform future training decisions.

From the graph below, the requirement achieved the least was 4.4.2, which deals with competence, training, and awareness: The organization shall implement procedures to ensure the persons working on its behalf are aware of the policy and procedures required within the standard and other environmental regulations. This is important to note because a common issue for the agencies is that the EMS program would lose momentum when the person or people who completed the EMS training left the agency. At that point the if the responsibility was not passed onto another person the agency EMS collapsed.

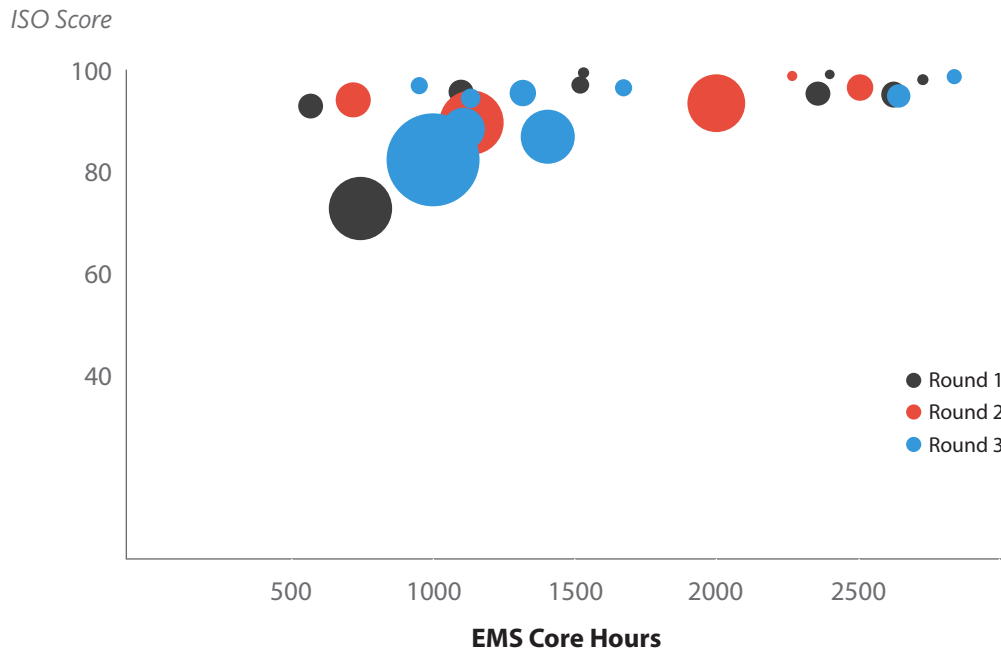
Figure 1: ISO 14001 Requirement Completion



The team analyzed the results of these audits to determine if there was an indicator for success with ISO 14001. Comparing the overall score with key characteristics from the audit reports, the only notable trend was the EMS core hours used in each transit agency. The graph below describes the relationship between the overall score and the core hours with the width of the bubble reflecting the standard deviation of individual requirements.

Figure 2: Overall Score versus EMS Core Hours

## FINDINGS | ISO 14001 AUDIT



From the graph, it is apparent that there is a great deal of variation with less than 1,500 EMS Core Hours and little variation after 2,300 EMS Core Hours. More relationships can be seen in Appendix A.

### Success Rubric

The outcome of the success rubric is summarized in the table below.

Table 1: Overall Score Summary

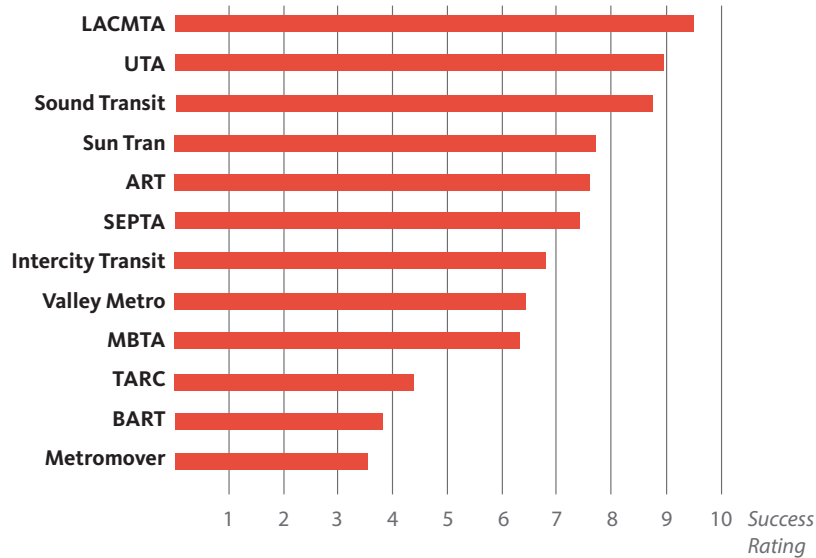
Agency	Success Rating
ART	7.55
BART	3.83
Intercity Transit	6.80
LACMTA	9.50
MBTA, Rd2	6.70
MBTA, Rd1	6.45
Metromover	3.50
SEPTA	7.45
Sound Transit	8.98
Sun Tran	7.70
TARC	4.58
UTA	8.93
Valley Metro	6.33
<b>Average</b>	<b>6.79</b>
<b>Standard Deviation</b>	<b>1.83</b>



The average success rating across the agencies is 6.79 with a standard deviation of 1.83. With such a high relative standard deviation, the success of each agency varies greatly. This deviation is represented in the graph below. The complete success rubric can be seen in Appendix B.

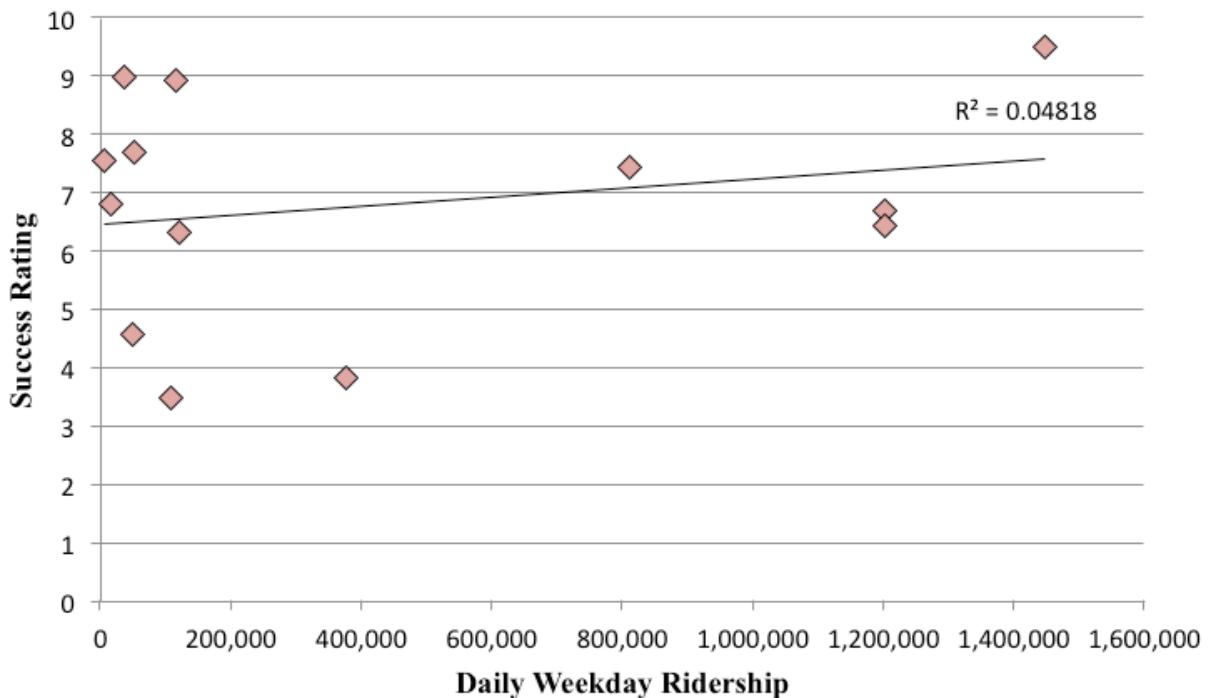
Figure 3: Overall Agency Success Rating

### FINDINGS | OVERALL SUCCESS



Part of the analysis included comparing the agency success to its key characteristics as well as its sustainability metrics to determine if there were any relationships. It is apparent that there was no correlation between the rated success and any key characteristic meaning that any agency can achieve EMS success. For example, the scatter plot below depicts the agency rated success versus ridership – a characteristic that the team thought would have some relationship.

Figure 4: Overall Agency Success Rating versus Daily Weekday Ridership



Included in the graph is the R<sup>2</sup> value to indicate the strength of correlation. With a low R<sup>2</sup> value, there is little relationship between the agency success and the daily weekday ridership – larger agencies with more daily riders were not necessarily more successful than smaller agencies. This comparison was done for each key characteristic identified. The resulting correlation coefficients can be seen in the table below and the graphs can be seen in Appendix C.

Table 2: Pearson Correlations for Key Characteristics

	<b>Pearson Coefficient</b>
Daily Weekday Ridership	0.220
Service Area	-0.078
Annual Operating Budget	0.147
Number of Employees Involved	0.135
EMS Core Hours	0.203

Table 3: Correlation Assumptions

	<b>Assumptions</b>
Alpha	0.050
Degrees of Freedom	11
Critical Value	0.553

A Pearson correlation coefficient was computed to assess the relationships between the rated sustainability success and various key characteristics. The correlation table indicates that none of the key characteristics are correlated with sustainability success because the values are all below the critical value indicated in Table 3.

Regional location was a key characteristic that is a qualitative analysis. The Southwest was the strongest region with an average success rating of 7.88 and the Midwest was the weakest with an average success of about 4.58. Please note that the Midwest region only had one agency representing it (TARC in Kansas City). Table of regional averages is depicted below.

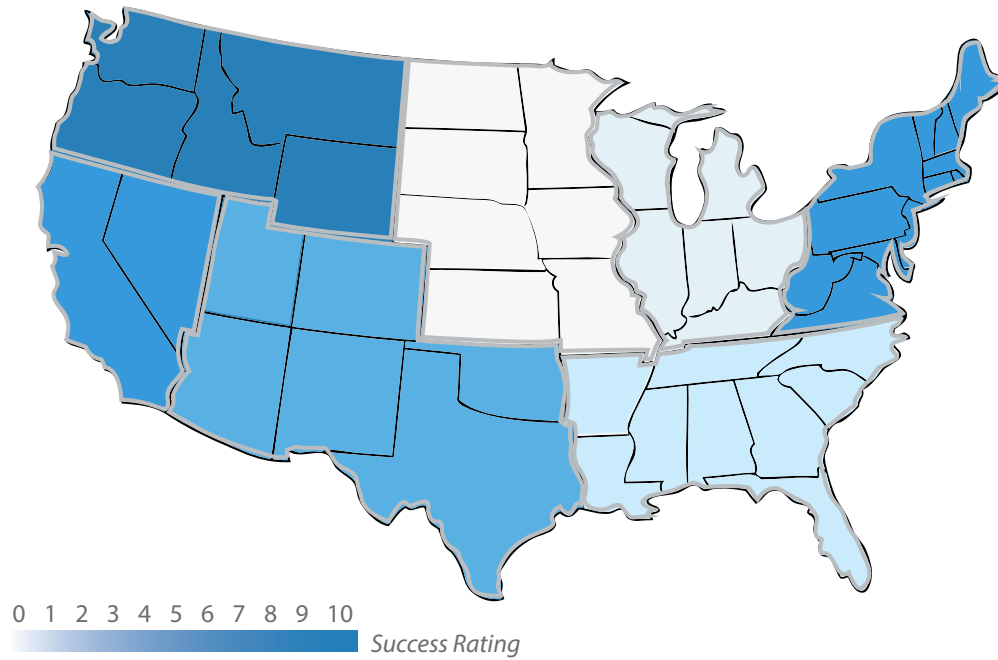
Table 4: Overall Success Rating by Region

<b>Region</b>	<b>Success Rating</b>
Midwest	4.58
Northeast	5.54
South	6.95
Southwest	7.88
West Coast	6.01
Overall	6.79

The table above can be visualized in the regional map depicted below.

Figure 5: Overall Success Rating versus Region

## FINDINGS | AVERAGE SUCCESS BY REGION COMPARISON



Further analysis was done to compare the rated success to the sustainability metrics. Unlike the key characteristics, there were some sustainability metrics that correlated with the EMS rated success. In Table 5 below, the metrics above the thick middle line have a Pearson Coefficient above the critical value and they indicate a positive correlation between the two variables. Overall, the strongest correlation came from if the agency produced a sustainability report. The tables below summarize the relationship between the rated success and the sustainability metric.

Table 5: Pearson Correlations for Sustainability Metrics

	<b>Pearson Coefficient</b>
Sustainability Report	0.880
Financial Savings	0.802
EMS Maintained	0.693
ISO Certification	0.693
Improved Environmental Performance	0.681
Sustainability Initiatives (Quantity and Diversity)	0.575
<b>Lowered Environmental Risk</b>	<b>0.519*</b>
<b>Increased Fence line after Training</b>	<b>0.044*</b>
<b>Number of Employees Involved with EMS</b>	<b>-0.030*</b>

*\*There was no correlation between Rated Success and Sustainability Metric*

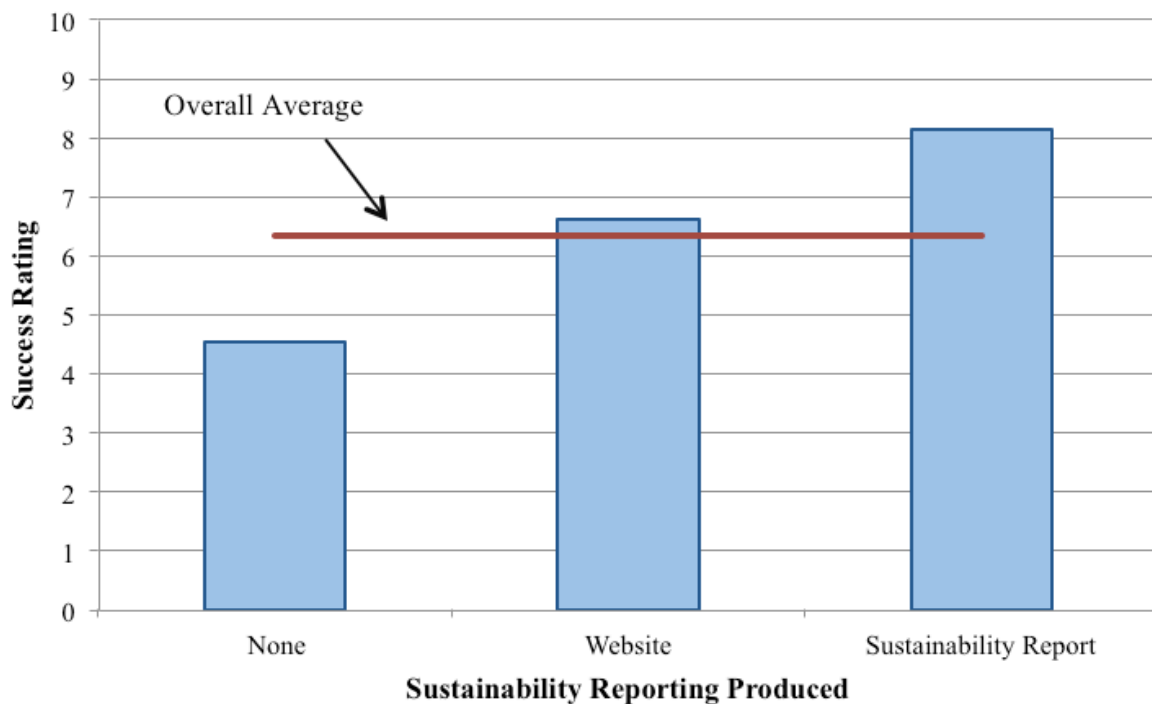
Table 6: Correlation Assumptions

## Assumptions

Alpha	0.050
Degrees of Freedom	11
Critical Value	0.553

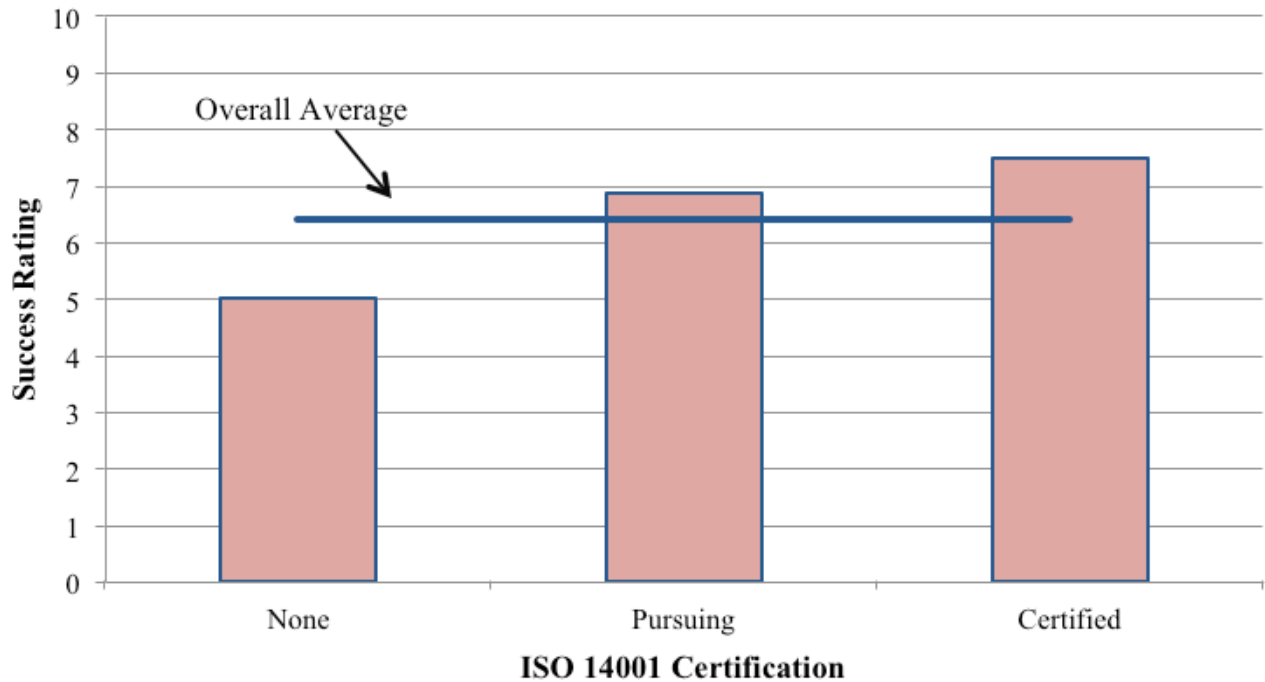
The Sustainability Report relationship is depicted in the graph below and the overall average is indicated for reference. For the Pearson Coefficient analysis, the effects of the metric on the sustainability success rating has been removed – normalizing the success rating. This is also why the overall average appears lower than what was previously indicated in Table 1.

Figure 6: Rated Success by Sustainability Reporting Type



Another important correlation to consider is the relationship between ISO 14001 certification and the rated success of the agency. The FTA emphasizes the standard in the training program so a correlation between the variables helps justify the program. The relationship is depicted in the bar graph below – again, the impact of the certification has been removed from the success rating for a normalized comparison.

Figure 7: Success Rating by ISO 14001 Certification



There is also a strong correlation between the financial savings and the rated success. In the analysis, the Return on Operating Budget was a factor in determining the Financial Savings rating for the rubric. The Pearson Coefficient between the Return on Operating Budget and the rated success was slightly lower (0.777) than with the Financial Savings rating (0.802), but still yields a strong, positive correlation. The scatter plot below summarizes the relationship. The remaining relationships are depicted in Appendix C.

Figure 8: Success Rating by Return on Operating Budget



## Financial Analysis Results

On average, annual return on operating budgets improved from ~0.29% from Round 1 participants to ~0.54% from Round 3 participants. Moreover, most agencies adopted either some or most of the EMS measures they learned during their training.

Additionally, each successive round saw generally higher levels of nominal savings as agencies seemed to adopt and embrace both the letter and spirit of EMS and sustainability measures. As the table below reflects, on average the annual return on operating budget is trending higher while annual benefits and cost savings also seem to be improving round to round.

One salient result of the financial analysis, was that higher returns on annual budget were not limited to larger transit agencies. Rather, agencies such as Sun Tran in Tuscon, AZ were also able to deliver higher returns on annual budgets, similar to Sound Transit in Seattle, WA. Moreover, agencies did not necessarily need to be certified under ISO 14001 in order to generate high returns—both certified and uncertified agencies were able to identify meaningful ways to implement their EMS initiatives and generate solid savings on an annual basis. However, ISO certification was a good indicator of financial savings.

Key areas of focus for economic and environmental savings were typically related to energy, fuel, water, and materials disposal and recycling. To a lesser degree, carbon dioxide and air quality issues were also an area where agencies tried to improve; however, such an effort was not as pervasive some of the other key areas identified above.

	Daily	EMS Investment	Annual Benefits/	Annual Operating	Return on	Annual Return
Round 1	Ridership	Cost	Cost Savings	Budget	Investment	on Op Budget
Sound Transit, WA	82,192	\$20,526,696	\$831,561	\$221,000,000	4.1%	0.38%
Phoeniz, AZ	118,225	\$101,000	\$49,000	\$260,425,000	48.5%	0.02%
BART-San Fran	376,475	\$145,655	\$40,000	\$672,100,000	27.5%	0.01%
TARC-KY	47,000	\$145,655	\$115,000	\$59,244,947	79.0%	0.19%
Tuscon	55,759	\$107,387	\$1,111,000	\$47,370,000	1034.6%	2.35%
Utah Transit Authority	117,260	\$100,000	\$1,782,169	\$325,503,600	1782.2%	0.55%
			Median= \$473,281		Median= 64%	0.29%
<b>Round 2</b>						
LACMT	491,905	\$650,000	\$11,040,849	\$1,345,000,000	1699%	0.82%
MBTA	1,295,412	\$655,000	\$3,746,918	\$1,932,869,836	572%	0.19%
Miami-Dade MDT	286,627	\$655,000	\$925,000	\$467,980,266	141%	0.20%
City of Asheville Transit	5,371	\$40,581	\$50,000	\$8,717,000	123%	0.57%
			Median= \$2,335,959		Median= 357%	0.39%
<b>Round 3</b>						
Intercity Transit-Olympia WA	15,068	\$105,000	\$297,000	\$35,700,000	283%	0.83%
SEPTA-SE Penn Trans Auth	924,110	\$655,000	\$3,200,000	\$1,282,764,000	489%	0.25%
			Median= \$1,748,500		Median= 386%	0.54%

## Key Conclusions

- › ISO 14001 requirements most complete with at least 1,500 EMS Core Hours.
- › Agencies are having difficulty completing the ISO 14001, 4.4.2 requirement, which deals with training and awareness of a sustainability program
- › EMS Training program and ISO 14001 certification has a positive correlation, emphasizing importance of ISO 14001 within program.

- > Positive correlations were found between Rated Sustainability Success and the following Sustainability Metrics:
  - » Sustainability Report
  - » Financial Savings
  - » EMS Maintained
  - » ISO Certification
  - » Improved Environmental Performance
- > Sustainability Initiatives (Quantity and Diversity) With no strong correlation between Rated Sustainability Success and Key Characteristics, any agency can find economic and environmental success with an EMS.
- > The higher returns on annual budgets were not limited to larger transit agencies
- > Key areas of focus for economic and environmental savings were typically related to energy, fuel, water, and materials disposal and recycling.
- > The EMS training program continues to show improved results over each round, as measured by average financial savings of participating agencies

## Case Study | Quantifying Financial Gains: Utah Transit Authority

The Utah Transit Authority (UTA) was selected as one of the first ten transit agencies to participate in the FTA's EMS program. Covering 1600 square miles of service area with 650 buses, 69 light rail vehicles and 400 vans, they had a great deal of room for progress. During training the team experienced the ISO management systems, and it became clear that the ISO framework was a perfect fit for UTA. They became the first ISO 9001 and ISO 14001 certified transit agency in December 2005.

Sustainability is now a core concept at UTA; it's also a core value embraced and practiced throughout the organization. They have shown leadership with alternative fuel vehicles, solar technology and clean diesel fuel. Initial savings from the EMS implementation were seen in fuel cost savings of \$675,000 and energy savings BTU per rider went from 25,500 BTUs to 23,000 BTUs within 2 years after EMS training (by 2004). Oil & grease discharge also improved by over 75% by falling from 50 mg/l to 12 mg/l.

UTA has now gone above and beyond their initial fence line and have incorporated a multitude of sustainable strategies, including supporting clean air initiatives such as pass programs and partnerships with other state and local Air Quality groups, operation of a balanced fleet of alternative fuel vehicles, and funding a 'State of Good Repair' program. They created a 'Front lines 2015' program, a forward-looking transit strategy to implement more sustainability measures into the agency as a result of its participation in the EMS program. By 2013 the Front lines 2015 program had reached its targets, two years ahead of schedule and under budget. Their goal is to continue to find ways to lower energy, water and materials costs as a result of the EMS training.

## Recommendations

Considering the program's success, both financially and environmentally, it is recommended that FTA continue funding the EMS training program. That said, through the data collection, interviews, and analysis, there are further recommendations to improve results. These recommendations regard training hours, goals and curriculum.

It was determined that transit agencies improved performance by dedicating at least 1,500 hours core training to the program. Applicants should therefore be selected taking into consideration their demonstrated willingness to commit to this level of training, including a clear plan for organizational ownership of the EMS moving forward. Furthermore, there seem to be diminishing returns after 2,500 hours, which could serve as a limit.

The team was also able to observe that a disproportionate amount of the EMS responsibility was vested in 1 or 2 key people. As we saw in Figure 1, requirement was 4.4.2, which deals with competence, training, and awareness, was the lowest rated. This, along with the communications received during the interviews, left the success and longevity of the EMS vulnerable to retention of those employees. Rather than focusing energies and resources on a selective group, the EMS training should extend beyond and incorporate a method for integrating environmental management into the agency culture on the whole. It is suggested that part of the training for managers should include introducing EMS responsibilities to as many employees as is feasible. This will enable the EMS to outlive any single employee and to become an inherent part of operations.

Lastly, there seems to be a disconnect between following procedures and processes, and keeping accurate, meticulous data on what has been committed to, and achieved by, the EMS. This includes environmental data, such as gallons of diesel combustion averted, but more importantly, financial data related to the investment, such as its initial cost, date of investment, savings/unit of time or savings/vehicle mile. Our suggestion is to standardize data tracking and reporting for EMS as part of the core curriculum. This becomes a critical part of the training: how to track and organize environmental investments and related financial data. With standardized data, the EMS training program can be more effectively evaluated.

## Conclusion

The EMS training program has proved to be a valuable management tool to effectively drive environmental and sustainable practices within the individual transit agencies. Using the ISO 14001 framework and assistance from Virginia Tech the EMS teams within agencies were able to identify and pursue environmental objectives while reducing costs and improving practices. Through this each agency was able to tailor the EMS program to work most effectively for their needs. FTA's role has been critical in providing the incentive and training to these agencies to help them realize their own potential.

As there was not a strong correlation between Rated Sustainability Success and any of the Key Characteristics, it is important to note that any agency can find economic and environmental success with an EMS. This is an important finding as the FTA continues to consider applicants for future rounds of the training program. Any agency should be encouraged to apply and gain experience through the EMS Training Program.

A more streamlined process of communication after completing the program would allow the FTA greater insight into the efficacy of the training program. Through a systematic approach of continued documentation and reporting the benefits realized by past participants could be passed onto future participants and improve upon the training program. FTA should strongly consider implementing a required reporting on a regular basis to capture the value of the training over the long-term. This would be beneficial for all parties; the agencies to track their efforts, the FTA to capture that information, and future trainees who can learn from their experiences.

It is important that the FTA continue to fund and promote this program to set an example of standard operations and best practices for transit agencies. Promising results from this training can be seen through enhanced environmental performance and positive return on investment. Working with the local transit agencies, the FTA can establish themselves in a leadership role for EMS training programs and provide assistance to all mass transit agencies who seek to improve their environmental performance.

## Acknowledgments

We would like to thank our advisor, Thomas Abdallah of New York City Transit, for his guidance, support, and encouragement during this project and keeping us positive throughout. We also want to acknowledge our client, Antoinette Quagliata, who assisted us with data gathering and defining the scope of work. Additional thanks go out to the local transit agencies who accepted our calls and took the time to respond to our survey questions.



# Appendix A: ISO 14001

Figure 1A: ISO 14001 Audit versus Daily Ridership

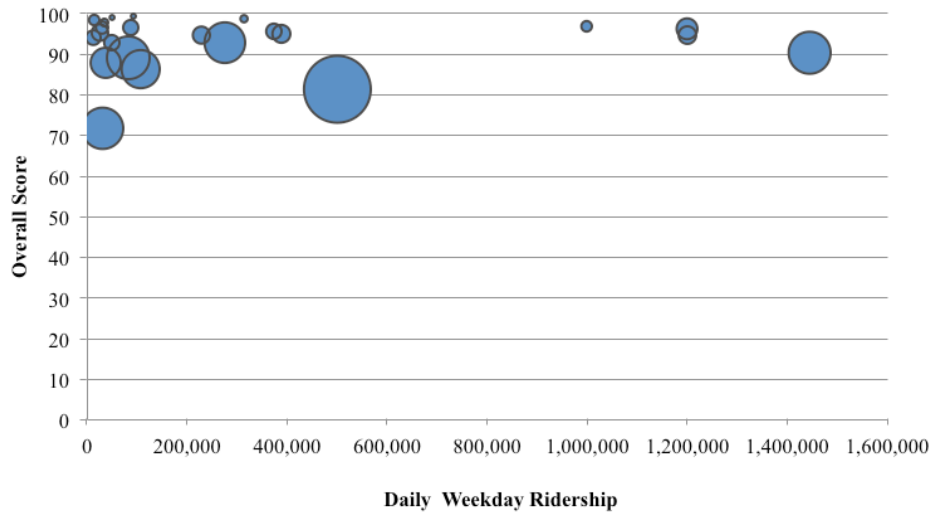


Figure 2A: ISO 14001 Audit versus Annual Savings

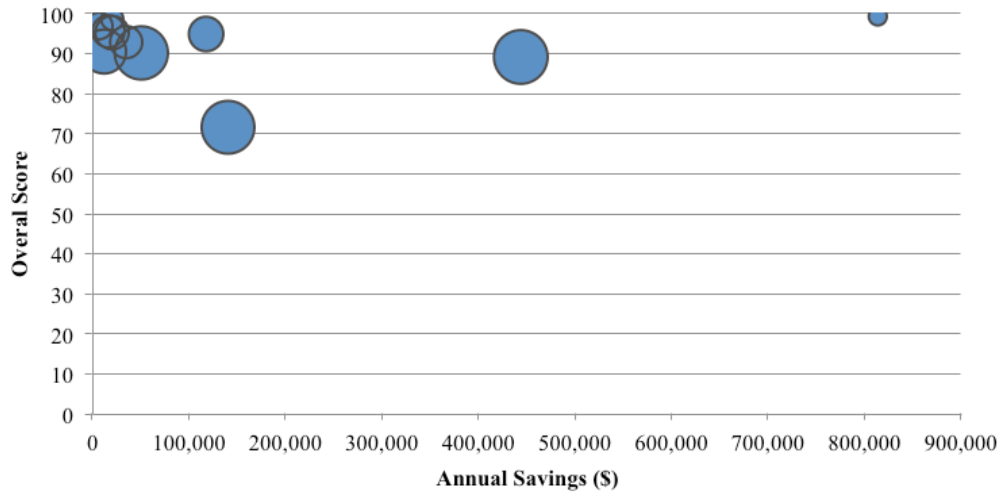
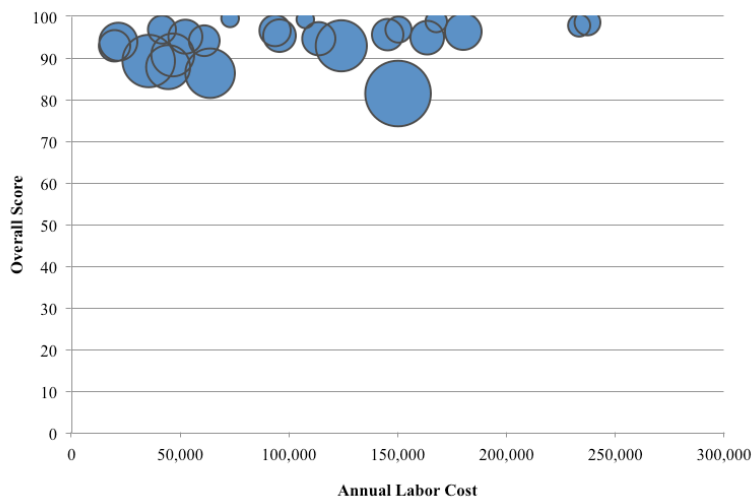


Figure 3A: ISO 14001 Audit versus Annual Savings



## Appendix B: Success Rubrics

Table 1B: Round 1 Success Rubric

		Agency Ratings							Metric Average
Round 1	Weight	BART	MBTA	Sound Transit	Sun Tran	TARC	UTA	Valley Metro	
ISO Certification	8%	0.00	0.00	10.00	10.00	0.00	10.00	10.00	5.71
Sustainability Report	10%	0.00	5.00	10.00	5.00	0.00	10.00	0.00	4.29
EMS maintained	15%	5.00	7.00	10.00	10.00	0.00	10.00	10.00	7.43
Financial Savings	25%	4.50	7.00	9.50	9.00	7.50	8.50	6.50	7.50
Increased Fence line	2%	0.00	10.00	0.00	10.00	10.00	0.00	10.00	5.71
Lowered Environmental Risk	5%	5.00	10.00	10.00	5.00	5.00	8.00	8.00	7.29
Number of Employees Involved	5%	10.00	3.00	4.00	4.00	2.00	10.00	2.00	5.00
Sustainability Initiatives	10%	4.00	7.00	8.00	5.00	7.50	10.00	3.00	6.36
Improved Environmental Performance	20%	4.00	8.00	9.00	7.50	7.00	8.00	7.00	7.21
<b>Rated Success</b>	<b>100%</b>	<b>3.83</b>	<b>6.45</b>	<b>8.98</b>	<b>7.70</b>	<b>4.58</b>	<b>8.93</b>	<b>6.33</b>	<b>6.68</b>

Table 2B: Round 2 Success Rubric

		Agency Ratings				Metric Average
Round 2	Weight	ART	MBTA	LACMTA	Metro mover	
ISO Certification	8%	5.00	0.00	10.00	0.00	3.75
Sustainability Report	10%	5.00	5.00	10.00	0.00	5.00
EMS maintained	15%	10.00	7.00	10.00	0.00	6.75
Financial Savings	25%	8.00	7.00	9.00	4.00	7.25
Increased Fence line	2%	0.00	10.00	10.00	0.00	5.00
Lowered Environmental Risk	5%	8.00	10.00	8.00	5.00	7.75
Number of Employees Involved	5%	7.00	3.00	7.00	7.00	6.00
Sustainability Initiatives	10%	8.00	7.00	10.00	5.00	7.50
Improved Environmental Performance	20%	8.00	8.00	10.00	7.00	8.25
<b>Rated Success</b>	<b>100%</b>	<b>7.55</b>	<b>6.45</b>	<b>9.50</b>	<b>3.50</b>	<b>6.81</b>

Table 3B: Round 3 Success Rubric

		<b>Agency Ratings</b>			
	<b>Round 3</b>	Weight	Intercity Transit	SEPTA	Metric Average
ISO Certification	8%		5.00	5.00	5.00
Sustainability Report	10%		5.00	5.00	5.00
EMS maintained	15%		10.00	10.00	10.00
Financial Savings	25%		8.00	7.00	7.50
Increased Fence line	2%		0.00	10.00	5.00
Lowered Environmental Risk	5%		10.00	10.00	10.00
Number of Employees Involved	5%		4.00	6.00	5.00
Sustainability Initiatives	10%		5.00	7.00	6.00
Improved Environmental Performance	20%		6.00	8.00	7.00
<b>Rated Success</b>	<b>100%</b>		<b>6.80</b>	<b>7.45</b>	<b>7.13</b>

Table 4B: Success Rubric Summary

<b>Overall Summary</b>	Weight	Round 1	Round 2	Round 3	Overall Average	Standard Deviation
ISO Certification	8%	5.71	3.75	5.00	5.00	4.34
Sustainability Report	10%	4.29	5.00	5.00	4.62	3.54
EMS maintained	15%	7.43	6.75	10.00	7.62	3.62
Financial Savings	25%	7.50	7.25	7.50	7.42	1.40
Increased Fence line	2%	5.71	5.00	5.00	5.38	4.26
Lowered Environmental Risk	5%	7.29	7.75	10.00	7.85	1.99
Number of Employees Involved	5%	5.00	6.00	5.00	5.31	2.29
Sustainability Initiatives	10%	6.36	7.50	6.00	6.65	1.93
Improved Environmental Performance	20%	7.21	8.25	7.00	7.50	0.89
<b>Rated Success</b>	<b>100%</b>	<b>6.68</b>	<b>6.81</b>	<b>7.13</b>	<b>6.79</b>	<b>1.68</b>

# Appendix C: Rated Success

Figure 4C: Rated Success by EMS Maintained

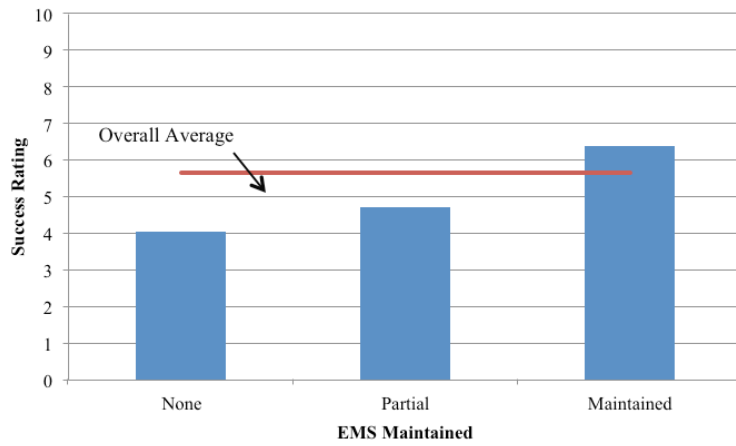


Figure 5C: Rated Success by Sustainability Initiatives

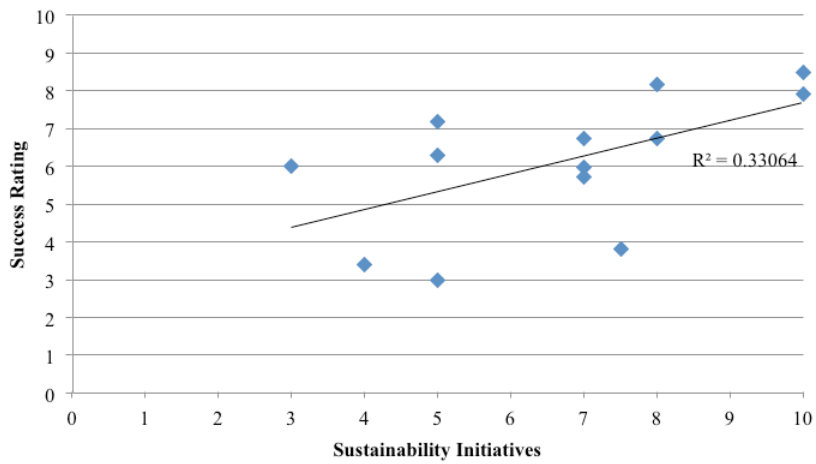


Figure 6C: Rated Success by Environmental Performance

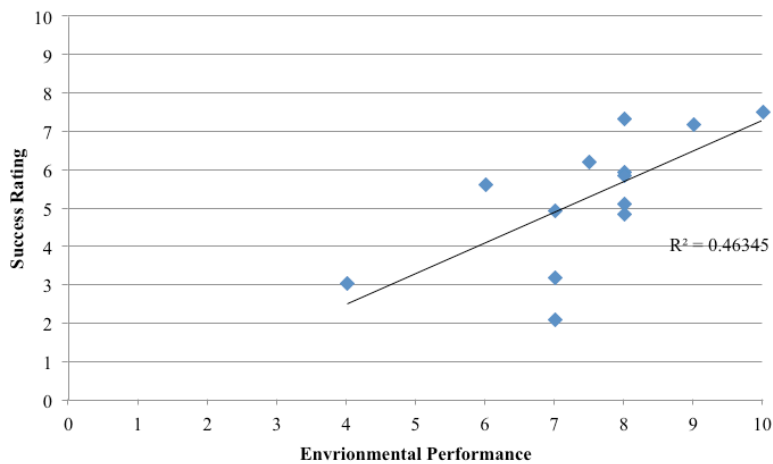


Figure 7C: Rated Success by EMS Core Hours

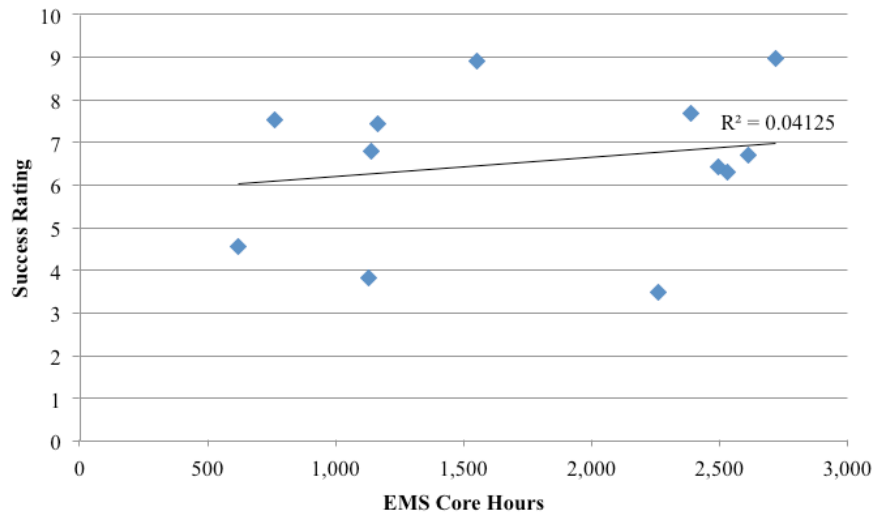


Figure 8C: Rated Success by Service Area

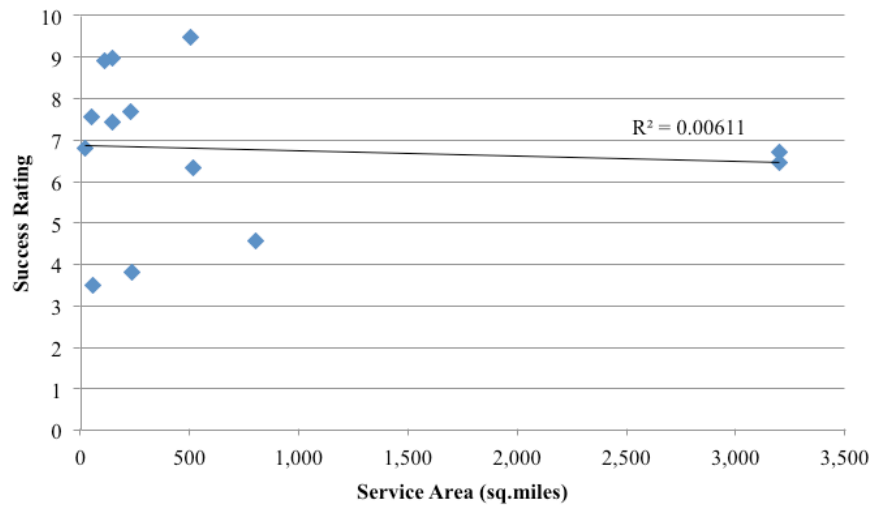


Figure 9C: Rated Success by Annual Operating Budget

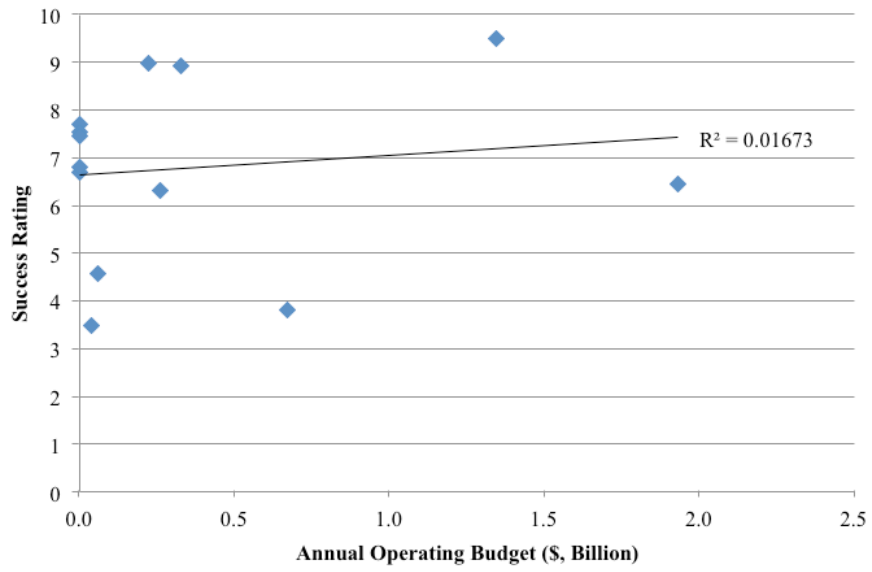
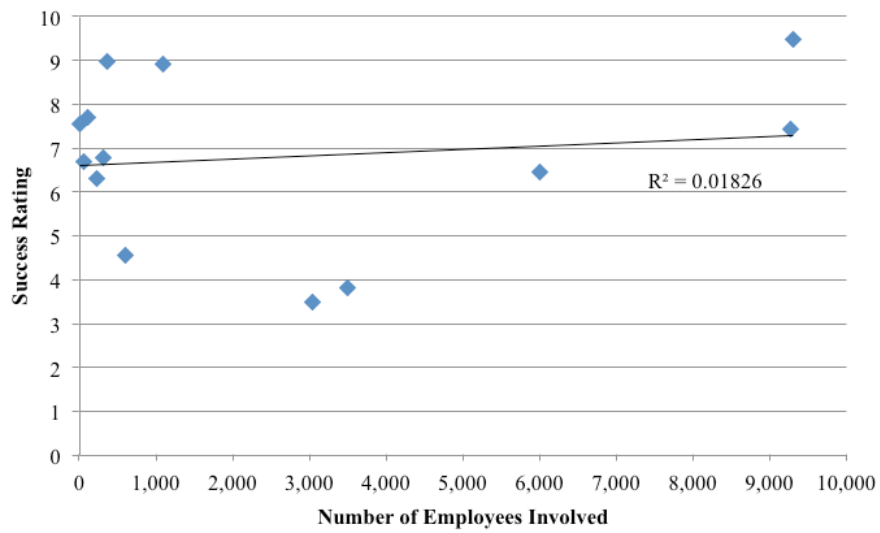


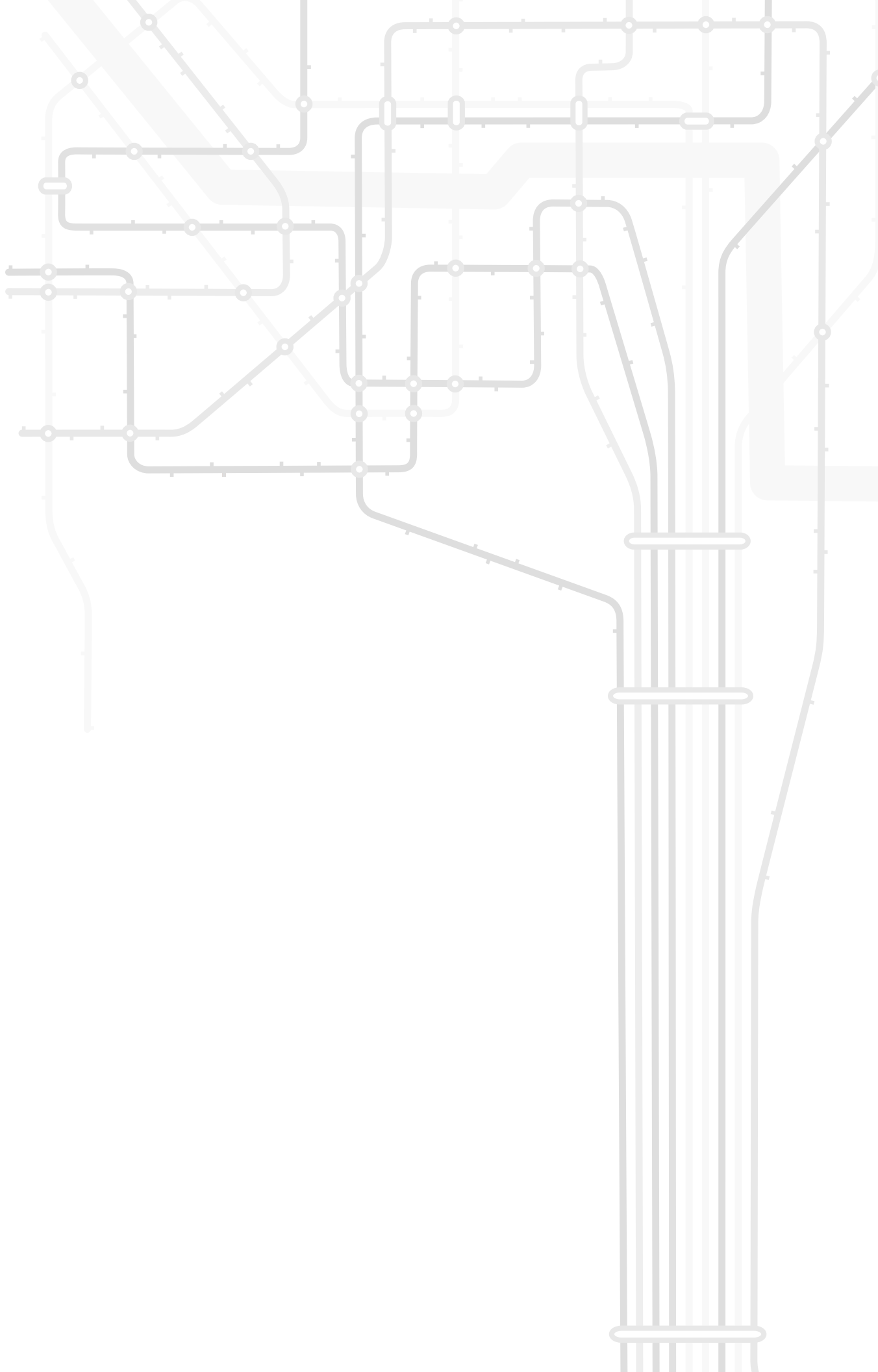
Figure 10C: Rated Success by Employees Involved



## Appendix D: Interviews

### Questions for interviews

1. What was your experience in the program?
2. How did the training affect your operations?
3. What impact did the EMS have on your operations?
4. Have you maintained the EMS? How has it changed?
5. Did you pursue ISO 14001 certification, are you maintaining that certification?
6. Did you set targets after the program, have you met these targets?
7. Do you have EMS data available that was collected since the end of the program?
8. Do you have a sustainability report? How has the program affected the sustainability report?
9. Potential improvements to the program?





# Thank you!

## **Spring 2014 Capstone Team**

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