New Jersey Department of Transportation
2006
RESEARCH IMPLEMENTATION REPORT

Dr. Claudia Knezek, CAIT - NJ LTAP
in cooperation with NJDOT Bureau of Research

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2006 NJDOT RESEARCH IMPLEMENTATION REPORT

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2006 NJDOT RESEARCH IMPLEMENTATION REPORT

Executive Summary

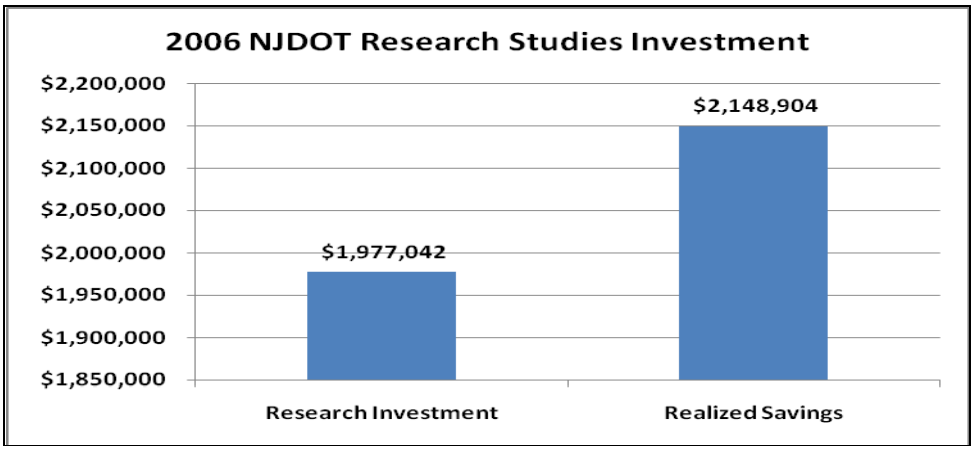
During the past three years, the New Jersey Department of Transportation (NJDOT), Bureau of Research, has funded nearly fifty research projects that support the transportation industry. Requested by industry customers, many of these projects solve important transportation problems, but limited information is known about the long-term effects of the studies. The Bureau is frequently approached by sponsors to justify the value of these projects to a much broader audience; therefore, the intent of this implementation is to identify the quantitative and qualitative benefits of NJDOT research projects that were completed in 2006.

Technology transfer benefits were measured on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions.

Principal Investigators from universities were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that investigators would report on additional studies and projects that had been generated as a consequence of this initial work. Since the information was not always available, the NJDOT customers were identified by investigators for each project. Interviews were arranged with the customers to establish, not only benefits, but follow up activities that happened as a result of the research.

Findings were as follows:

- Over 70% of researchers conducted 22 presentations and wrote 21 publications that were distributed throughout the United States and in Europe.
- Three Master's thesis studies were produced in conjunction with the NJDOT sponsored research and one study was even presented abroad at the University of Antwerp.
- One third of the products, computer software systems and decision-making tools, were showcased at the federal, state, and local levels.
- The most important gains from these projects were the potential for reducing crashes and severe injuries, along with increased roadway mobility, and improvement of the environment.

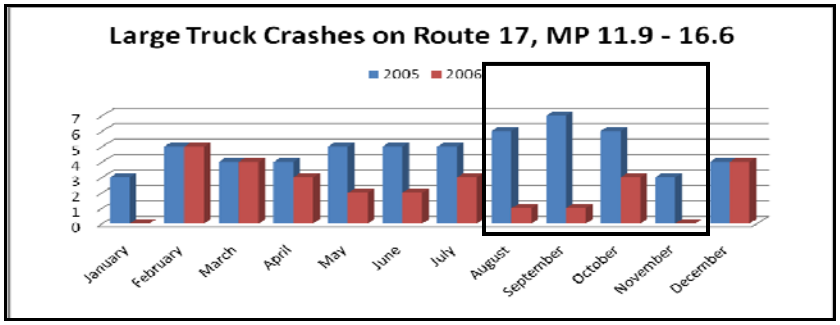


When comparing the research investment of 1,980, 000 to the realized savings, $2,150,000 just two years later has been based on the reduction of truck crashes and the provision of technical services to municipalities. Also, potential savings have been identified at $20,000,000 over the course of (several years) time, but conditions must first be met that include additional investments by the NJDOT to fully implement projects on a statewide level.

NJDOT Realized Savings

The project, Development and Implementation of an Awareness, Education, and Enforcement Campaign Regarding Illegal Truck Movement Along Route 17 in Paramus, NJ, determined to what extent trucks were traveling illegally in the left lane on Route 17, located in Paramus. Next, test methods were developed to alleviate the problem. Also, a series of partnerships were formed between local enforcement, a New Jersey State Senator, the NJDOT, and NJIT to develop and support solutions to improve safety conditions on this roadway. Safety improvements were accomplished through the use of technical instruments to capture the extent of the problem and then develop educational resources to address the issue.

Currently available information on national truck crash costs was estimated at $91,112 per crash. In Bergen County, 130 crashes increased between 2005 and 2006, at Mile Posts 11.96 to 16.54. However, the number of large truck crashes decreased by 77% from the previous year; which had shown a savings of $1,548,904 based at the time of the research activities.



Source: *Rutgers, TSRC, 4/08.*

County and Municipal Realized Savings

In addition to the NJDOT, the three New Jersey Metropolitan Planning Organizations (MPOs) were project customers. The MPOs provided input on the selection of local agencies for the implementation of the Pavement Management System. The following local government agencies received technical support in the form of technology transfer or implementation tasks:

- Hamilton Township
- Jersey City
- Ocean County
- Salem County
- Union County
- City of Vineland

The technology transfer tasks included educating local government engineers on PMS concepts and benefits of the program. A series of workshops and a statewide conference was conducted for local agencies. Six PMS programs were implemented that included developing a base PMS, data collection, conducting a pilot implementation and presenting the results to the agencies for feedback.

Road network conditions were evaluated in terms of the NJDOT Ride Quality Index (RQI), Surface Distress Index (SDI), and the NJDOT overall Final Pavement Rating (FPR). Two analysis tools were used that included decision trees and performance prediction models. The decision tree was used for flexible pavements and analysis, while the performance prediction models were customized to reflect the service life of pavements. A cost savings of $100,000 for the development and installation of each PMS system was realized by each of the six agencies.

2006 NJDOT RESEARCH IMPLEMENTATION REPORT

Introduction

During the past three years, the New Jersey Department of Transportation (NJDOT), Bureau of Research, has funded nearly fifty research projects that support the transportation industry. Requested by industry customers, many of these projects solve important transportation problems, but limited information is known about the long-term effects of the studies. The Bureau is frequently approached by sponsors to justify the value of these projects to a much broader audience; therefore, the intent of this implementation study is to identify the quantitative and qualitative benefits of NJDOT research projects that were completed in 2006.

About the New Jersey Department of Transportation Bureau of Research

The Bureau of Research is responsible for delivering quality research and technology transfer solutions through a customer-focused program. This research is dedicated to identifying new products, improving existing processes, and refining systems that support the transportation infrastructure, enhance public safety, improve mobility, reduce congestion, protect the environment, and introduce innovative technologies to New Jersey based customers. The Bureau serves every unit within the Department of Transportation, Motor Vehicle Commission, and New Jersey Transit (NJDOT, 2007).

Surveys and literature searches, demonstration projects, and research studies are conducted by University partners and consultants. Most research studies are conducted by, but not limited to the following universities:

Academic Research Partners

New Jersey Institute of Technology

Princeton University

Rowan University

Rutgers, The State University of New Jersey

Stevens Institute of Technology

The College of New Jersey

University Transportation Research Center Consortium

Members of the UTRC Consortium

- City University of New York (CUNY)*
- Columbia University (Columbia)
- Cornell University (Cornell)
- New Jersey Institute of Technology
- New York University (NYU)
- Polytechnic University (Polytechnic)
- Rensselaer Polytechnic Institute (RPI)
- Rowan University (Rowan)
- Rutgers University. The State University of New Jersey*
- State University of New York (SUNY)
- Stevens Institute of Technology (Stevens)
- University of Puerto Rico - Mayagüez (UPRM)

**USDOT University Transportation Centers*

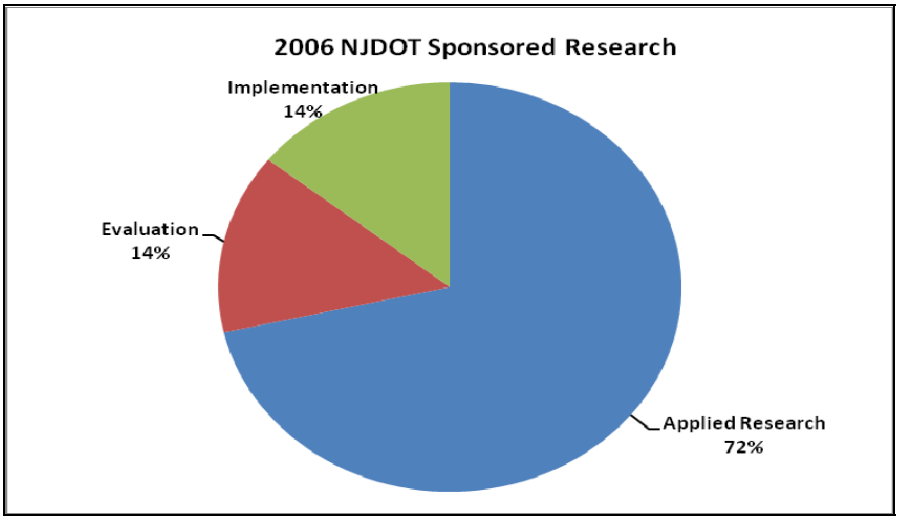
Methodology

The purpose of this follow-up study has been to track and quantify the outcomes of funded research that was completed in 2006. Technology transfer benefits were measured on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions (See implementation study interview form on page 28.)

Project Investigators were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that investigators would report on additional studies and projects that had been generated as a consequence of this initial work. Since the information was not always available, the NJDOT customers were identified by investigators for each project. Interviews were arranged with the customers to establish, not only benefits, but follow up activities that happened as a result of the research. When required, the NJDOT project managers were also used as technical resources on projects.

2006 NJDOT Research Project Review

In 2006, most of the completed research projects focused on applied research (72%), one study involved the local implementation of a Pavement Management System, and another evaluated existing safety devices for use in the State. Half of these projects produced computer-based decision tools for customers (i.e. traffic signal systems, intermodal containers, and a pavement management system). Other products were developed that included an enhanced emergency locator transmitter for aircraft, diesel fuel reduction alternatives, and an education/enforcement campaign for truckers. Brief project descriptions appear in the following section, along with the results of a follow-up survey that was completed by principal investigators and project customers.



FHWA-NJ 2006-001: Evaluation of Adaptive Control Strategies for New Jersey Highways – Dr. Kahn Ozbay, Rutgers University

Cost: $318,458.

Summary

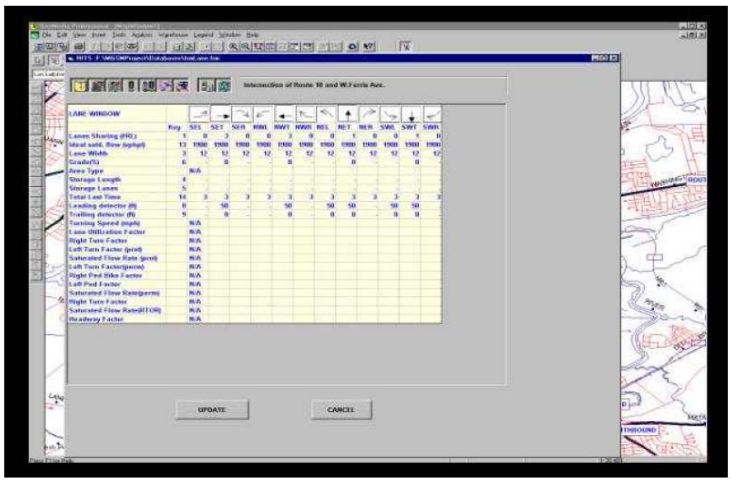
Throughout the country, traffic adaptive signal systems are installed to alleviate some of the worsening traffic congestion problems. In New Jersey, the NJDOT and various other transportation agencies are considering implementing traffic adaptive signal systems for Newark and Trenton, while New Brunswick has already installed such a system. However, it is still unclear if these adaptive signal systems provide benefits that justify the cost of installation and operations. The following four factors were considered in implementing adaptive signals:

- Geometric configuration of signalized intersections,

- Current and projected traffic conditions,
- Transportation corridors in which traffic signals are located, and
- Control strategies (e.g. OPAC, RT-TRACS, RHODES, SCOOT, and SCATS etc.).

The objective of this project was to develop a computer-based decision support system (DSS). This system accounts for uncertainties that directly affect the performance of these signal system and implement a computerized prototype to be employed by the NJDOT for the purpose of prioritizing the selection of the best upgrade candidates in an efficient and methodical way. The efficient development and usage of the prototype DSS tool includes the following:

- Identifying the input needs of the developed DSS tool,
- Assessing the availability of the input needs of this DSS tool within the NJDOT traffic signal inventory,
- Developing a plan to update the current NJDOT signal inventory according to the needs of the DSS tool,
- Identifying the most user-friendly graphical user interface, especially the input and output functions of the developed system, and
- Identifying the best outputs of the developed system.



Implementation

The research component of this project included conducting a comprehensive literature review of adaptive traffic signal control systems, using data from portions of Routes 10, 23, and 18 for inclusion in the development of the DSS prototype, and the development of a database in a GIS format. The final result was the development of the integrated DSS model, a system of four major modules (Input-Output Module, Knowledge Based Expert Systems, Macroscopic Simulation Module, and Benefit-Cost Analysis). Also, a series of case studies on selected intersections from the database were conducted to demonstrate factors that affect various adaptive signal strategies.

Mike Asson, NJDOT Traffic Engineer, was identified as the research customer for this project, but he has since retired from the agency. In the past, this simulation model was successfully demonstrated at NJDOT to identify the most suitable intersections for adaptive control and accurate assessment of their potential benefits over the existing control system. A series of publications and presentations, based on this research, were presented at the annual TRB Conference. According to the Principal Investigator, the benefits of this research included improvement of roadway capacity and safety (Table 1). Also, a recommendation was made for the NJDOT Bureau of Research staff to convene meetings with researchers, in order to resolve transportation problems through collaboration with several universities.

Adaptive Control Strategies for New Jersey Highways Survey Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	
Media/ Marketing		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Patricia Ott, Director of Traffic Engineering and Safety, was interviewed on the obstacles and benefits of this type of technology. It does not appear that the computer software developed for this project has been used in her Division. She is very interested in implementing the concept of adaptive technology for traffic control and has encouraged her staff to consider such options. However, additional research needs to be done to determine if and where an adaptive system could be accommodated in the State. The NJDOT traffic signal systems are responsive, and not adaptive, which is required for reducing congestion and improving safety.

Since adaptive technologies have improved over time, a new study is needed to identify locations with the potential to benefit from such a system and support labor savings for the Department. The technology itself is good, and not an issue, especially since the commitment to technology is welcomed and there would be no need for changes in policy. The implementation of such research would take the Department to the next level of technology.

Key aspects of an adaptive system would support the reduction of congestion and air pollution, and improve safety on roadways and at intersections. Common intersection crashes are rear end and right angle crashes. A consistent traffic flow with predictability would reduce these types of crashes, as well as red light running actions.

Further Recommendations

There has always been the criticism that research is not practical. The private sector may be the answer since NJDOT cannot "develop" a product. A new "middle man" is needed, who takes research findings and implements/builds a product for the client. There might be an opportunity to further implement research projects. In general, university researchers could develop specifications for the builder ("Middle Man" such as a controller vendor) who produces the product for NJDOT to implement. This would be the logical flow. A public-private partnership could translate into good business, but the private entity must make an investment.

Projected Cost Benefit/Economic Impact

Michael Meyer (2008) conducted recent research on the cost of crashes and congestion to society. Using data from the 2005 Urban Mobility Report, he found that improving safety may also improve congestion, since 40 to 50% of all nonrecurring congestion is associated with traffic incidents. In 2005, per person cost of a fatality is $3,246,192 and the cost for an injury is $68,170. He also found that the New York, New Jersey, Pennsylvania region had the highest cost for crashes in the country. A previous Transportation Research Board study, produced by Park & Chang (2002), established the benefits of adaptive signal control systems as reducing traffic flow delays by 18 and 20 percent. Based on this information, the projected cost benefit of implementing an adaptive signal control system at the NJDOT had been

estimated at $2,023,000 in savings, 18% of the New Jersey current crash costs (255,425), and $817,000 savings identified as congestion costs.

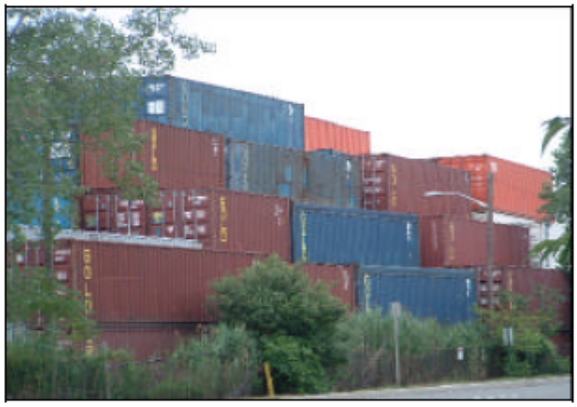
Another comprehensive study that was conducted in California by Skabardonis during this period, found that the estimated benefit for optimizing signal timing plans, coordinating traffic signal control, and implementing adaptive signal controls was 17:1. This calculation may be used as an overall savings estimate, as well determine future savings in realized labor costs.

FHWA-NJ 2006-005: Empty Intermodal Container Management – Dr. M. Boile, Rutgers University

Cost: $72,282.

Summary

A major inefficiency with intermodal shipping container transport is the accumulation of empty containers that are stacked along the coasts, stored at empty depot locations, or shipped back to Asia, the point of origin. The study evaluated alternative strategies for addressing storage and accumulation, as well as cost efficient reuse, recycling, and disposal of containers. An international literature review was conducted to confirm the causes of accumulated empty containers and identify proven best practices to create a methodology of short, medium, and long-term solutions for dealing with this problem.



First, international solutions were examined on addressing the accumulation of empty intermodal containers, and then a case study was conducted of the Port of New York/New Jersey. The results showed that there had been a fundamental imbalance of trade between the Eastern and Western countries. Also, other factors contributed to the surplus of shipping containers that included the following:

- Tariff imbalances,
- Cost of repositioning of empty containers from surplus to deficit areas,
- Inland transportation charges,
- Marginal profitability of the leasing industry,
- Purchasing versus leasing charges,
- Contract terms between leasing companies and ocean carriers, and
- Inspection fees on containers.

A decision support tool was developed, using a GIS framework, to include various stakeholders in the decision-making process of determining the most effective primary and secondary measures, and regional policies to reduce the accumulation of empty containers.

Implementation

According to the researcher, this study was commissioned by NJDOT Freight Planning to find a solution for the empty container issue. The project produced several publications and presentations that were conducted on behalf of the NJDOT. Research findings were disseminated at various conferences and several MPO meetings (NJTPA and NYMTC). The researcher was also invited to present these findings at the University of Antwerp and Washington State University. A list of the publications appears below:

- Boile, M. and Theofanis, S. "Empty Marine Container Accumulation in a Port Megacity Region", Proceedings of the 2007 Conference of the Association of American Geographers, April 17-21, San Francisco, California.
- Boile, M. (2006) "Empty Marine Container Management – Global Trends and Challenges" Shipping, No 418, Vol. 264
- Boile, M., Theofanis S., Golias M. and Mittal N. (2006) "Empty Marine Container Management: Addressing Locally a Global Problem" Proceedings of the 85th Annual Meeting of the Transportation Research Board, January 23-26, Washington, D.C.
- Boile M., Theofanis S., and Mittal N. (2004) "Empty Intermodal Containers – A Global Issue" Proceedings of the Transportation Research Forum 2004 Annual Forum. Northwestern University, Transportation Center, March 21-23, Evanston, Illinois

This electronic decision support tool was developed for the NJDOT customer, which enabled NJDOT and stakeholder agencies to make informed decisions on reducing the accumulation of empty containers. Although important, little information was available on the cost benefits of removing empty containers. If the research recommendations were implemented by the project stakeholders (i.e. leasing companies, depot, terminal operators, Port Authority, NJDOT and local government), cost benefits would be fully realized in the region.

Empty Intermodal Container Management Project Survey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer(Findings/Dissemination)	✓	✓
Marketing/Media		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	

Talvin Davis and Paul Truban, representatives from NJDOT Freight Planning, had been able to provide insight on why the study was conducted (Table 3). In 2002, their office was part of the DOT sponsored Logistics Council. A major problem was to identify and seek solutions for reducing the large quantity of empty shipping containers being stored at the Port of New York and New Jersey. Since this land is very valuable, it was important to remove the empty containers by sending them back to their point of origin or to effectively recycle them.

According to Davis, the magnitude of this problem has lessened over time. Since the issue of empty storage containers does not directly impact the highway infrastructure, there has been no change in the State's policy toward their removal. The containers are currently being stored on land that has been identified as brown fields, which are frequently too costly to clean up. There is little motivation for current land owners to improve the situation, since revenues are being generated from storage.

The greatest benefit of this research project was promoting public and industry awareness of empty storage container issues. Knowledge transfer has been excellent and is still ongoing at Universities, the NJTPA Freight Committee, and

industry groups throughout the State. It is probable that public awareness did influence the efficient reuse of containers, while improvements in the export industry contributed to a reduction of the problem in this region. There are no quantifiable benefits right now, except for the potential to redevelop valuable land once the containers are removed. Maintenance Labor costs could decrease if containers are removed from their present location.

Future Recommendations

The containers remain an eyesore in the Newark area and the problem appears to be spreading to neighboring areas, especially where distribution centers and warehouses are located. The expansion of this problem has given the illusion that the situation is improving, which may not be the case. A policy change in the City of Newark would require immediate action on removing the containers, especially if the safety of people living near them is involved. Therefore, Freight Planning staff members would team with the Research Bureau to implement solutions for improving aesthetic, environmental, and safety conditions for the Newark area. To date, the Bureau has been instrumental in enabling NJDOT customers to use university resources for resolving their immediate transportation problems.

Projected Cost Benefit/Economic Impact

According to ROI Container Cargo Alliance (2002), decision support tools have been proven to add value to the management process in the container fleet and voyage management areas. Immediately, a 5% reduction in cargo contributions is realized as well as a 10% reduction in repositioning costs. The overall impact of tighter stock controls results in lower leasing costs, reduced storage charges, lower insurance premiums, reduced administration charges, and lower communication expenses. As per Boile's findings of 150,000 empty containers being housed at this site with a repositioning cost of $1,200, the adoption of this decision making tool was projected to save $18,000,000 on repositioning costs.

FHWA-NJ 2006-006: Identification of Traffic Control Devices for Mobile and Short Duration Work Operations – Dr. R. Paaswell, University Transportation Research Center, City College of New York

Cost: $72,294.

Summary

The objective of this research project was to study mobile and short duration work zone safety devices and identify the best solution for improving safety and reducing crashes in work zones. The safety devices were reviewed based on their ability to maximize the protection of motorists, improve safety conditions for employees in work zones, and support those responsible for the setting-up of work zones. The equipment also had to meet the current internal standards of the NJDOT.

A national literature search was conducted on mobile and short duration work zone safety technologies being promoted by TRB, NCHRP, FHWA, State DOT's and other agencies. This review identified the following applicable devices:

- Fluorescent/bright signs,
- Reflectorized/bright suits and vests,
- Drone radar and speed indicator/displays,
- Remotely operated autoflagger,
- Truck mounted attenuators and message boards,
- CB wizard alert system,
- Rumble strips,
- Intrusion alarm, and
- Lane merger system.

According to the TRB and NCHRP literature, State DOTs use the MUTCD and a caravan approach to mobile and short duration work zones. Also, SHRP recommended devices for improving worker efficiency and safety, which include the Cone Shooter, Automated Pavement Crack Sealer, Automated Debris Removal Vehicle, the Balsi Beam, and Robotic Highway Safety Markers. The Balsi Beam appeared to have the greatest potential for ensuring worker safety in short duration work zones. The California Department of Transportation (Caltrans) had successfully developed this product

for high speed interstate highways. A second prototype Balsi Beam was being used on Route I-80 between Marysville and Reno, NV. Caltrans and the FHWA were recruiting State DOTs from the Eastern Region to adopt this device, which would be ideal for use along major roadways like Route I-80 in the northern region of New Jersey.

The NJDOT could obtain the license from Caltrans to fabricate and implement the Balsi Beam for use in selected short-term work zones. A work plan needed to be developed to secure a licensing agreement with Caltrans for the fabrication, delivery, inspection, and implementation of the Balsi Beam on the East Coast. Other research recommendations included the implementation of "Bright Zone Signs" by NJDOT to improve worker safety and visibility in work zones.

Implementation

Anthony Pellegrino, of NJDOT Employee Safety, requested that this research be conducted in order to identify new safety devices for employees working on roadways. No additional publications were written after the evaluation report was completed. The study confirmed that future cost savings would be gained by NJDOT once the Balsi Beam was fabricated and tested. Specifically, safety benefits would be realized for both motorists and workers exposed to high speed locations. The set up time was reduced to ten minutes and fewer vehicles were required in the work zone with this type of protection. Lastly, the New York State Department of Transportation approached CCNY researchers for recommendations on fabricating the Balsi Beam for use in their State.

The primary benefit of the research study was knowledge gained from evaluation of new safety devices. In addition to participating in the NJDOT Annual Research Showcase, a power point program was presented by the researcher in all NJDOT regions. The North Region appeared to be the most interested in using the Balsi Beam on short term assignments. Since the Balsi Beam was developed by Caltrans for FHWA, no marketing activities were conducted, except the researchers did share their findings with NYDOT employees, who were interested in partnering with the NJDOT on this project.

Traffic Control Devices for Mobile and Short Duration Work Operations Survey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

The value of implementing the Balsi Beam is worker safety, but there are also savings in labor and equipment. Adoption of the Balsi Beam would benefit motorists and reduce traffic congestion by closing only one lane of traffic instead of two. Possible cost savings may be measured by comparing loss of life against the cost of the device.

Future Recommendations

There are two major obstacles to implementing the Balsi Beam: the cost of building the device is approximately $400,000 and there is a licensing fee of $37,000 that must be paid to Caltrans. Presently, the researcher and the NJDOT Bureau of Research are investigating the possibility of sharing costs between two sponsoring agencies, reducing the manufacturing costs, and elimination of a licensing fee. Also, NJDOT Employee Safety has applied for an additional $100,000 in funding to be used for the implementation phase of this project.

If additional funding is not available, FHWA – NJ Division representatives will be contacted to provide support on helping to reduce the expense of manufacturing this equipment and eliminating the licensing fee. Future options also include the use of private sector manufacturers to develop the Balsi Beam equipment for the NJDOT. In the past, many benefits were realized by private companies becoming sole source providers. Once this equipment is successfully bid, it would be housed in the Central Region to better facilitate statewide access to the Beam.

Projected Cost Benefit/Economic Impact

Using Meyer's (2008) fatal crash cost average of $2665 per crash, the estimated savings associated with the Balsi Beam is $10,660. In 2006, four workers were killed on state roadways. Also, 100 minutes per day would be realized in labor savings when the Balsi Beam is adopted at the NJDOT.

FHWA-NJ 2006-009: Development and Implementation of an Awareness, Education, and Enforcement Campaign Regarding Illegal Truck Movement Along Route 17 in Paramus, N.J. – Colette Santasieri, NJIT

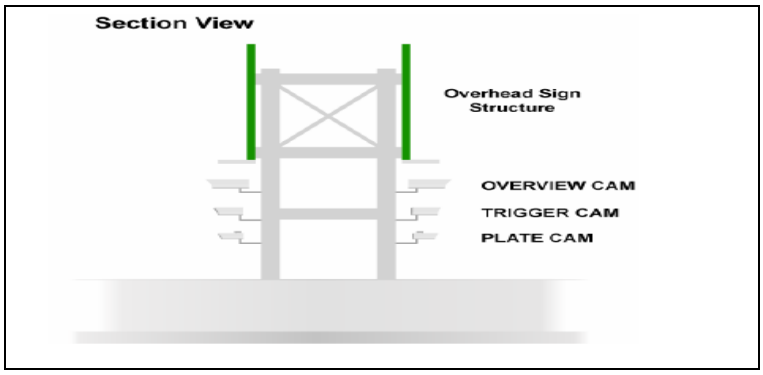
Cost: $150,000 NJDOT Contribution (Cosponsored by MPOs).

Summary

This project was established to determine to what extent trucks were traveling illegally in the left lane on Route 17, located in Paramus. Next, test methods were developed to alleviate the problem. Also, a series of partnerships were formed between local enforcement, a New Jersey State Senator, the NJDOT, and NJIT to develop and support solutions to improve safety conditions on this roadway. Safety improvements were accomplished through the use of technical instruments to capture the extent of the problem and then develop educational resources to address the issue.

The roadway studied, Route 17 of Bergen County, continues to be one of the State's most heavily traveled truck routes that provides access to the New York State Thruway for freight destinations in New Jersey and beyond. Illegal movements of trucks traveling in the left lane of a three-lane highway frequently occurred on various state highways throughout New Jersey. Although the problem was observed by motorists and law enforcement officials, the scope of illegal movement had not been previously documented.

The Route 17 Working Group of influential stakeholders was established to support this project, which included the use of a Traffic Pattern Video Monitoring System that was developed for this project. The system included using four high-resolution Day/Night capable digital signal processing cameras, two specialized license plate imaging cameras, and a digital recording system that was designed by EarthCam to capture violators. The device was installed on two overhead sign structures and used to monitor truck movements during two phases of the project.



A pre and post educational campaign was conducted to deter trucks from using the left lane, which included the following applications:

- Use of variable message signs,
- Placement of new permanent signs,
- Publishing notices in various trade publications,
- Dissemination of notices through email and faxes,
- Advertisement on XM radio, and
- Warning notices that were mailed to violators whose vehicles were captured on cameras.

The truck restriction analysis provided several results that were mainly attributed to the educational campaign.

Illegal Truck Movement (Left Lane Use) Campaign Findings

Location	Pre Test Activity	Post Test Activity
Century Road	Not specified	23% reduction
Linwood Avenue	Unspecified	27 % reduction northbound 8% reduction southbound
Century Road Overpass	4.3% northbound 4.4% southbound	0.9% northbound 3.0% southbound
Midland Avenue Overpass	5.5% northbound 4.3% southbound	Almost zero violations
Paramus Park Overpass	5.1% northbound 5.4% southbound	Almost zero violations
Ridgewood Road Overpass	3.5% northbound 3.0% southbound	0.2% both directions

Since the installation of new signs proved successful in reducing the number of trucks in the left lane, it was recommended that NJDOT paint "No Trucks in Left Lane" on the roadway at locations with the most violations. Also, corresponding messages needed to be placed at locations throughout the area. Canadian drivers were predominantly violating the regulation, so Canadian trucking organizations needed to be contacted by NJDOT on "rules of the road" information. Lastly, the video monitoring system should remain in place to further observe driver behaviors, obtain traffic counts, and monitor the area.

Implementation

The research customer was identified as the NJDOT and the North Jersey Transportation Planning Authority. No publications or presentations were generated from this project, except for the final report and technical brief. The cost savings could not be determined; however, there were safety benefits for travelers due to the decrease in trucks traveling illegally in the left lane of Route 17.

As confirmed by Talvin Davis and Paul Truban of NJDOT Freight Planning, this project was very successful in accomplishing the goal of getting trucks out of the left lane. The problem was identified and measured for effectiveness. The number of trucks traveling in the left lane was reduced and local government agencies were satisfied. The New Jersey Transportation Planning Authority (NJTPA) was involved in the project, as well as the municipalities along Route 17, an access road to and from New York State.

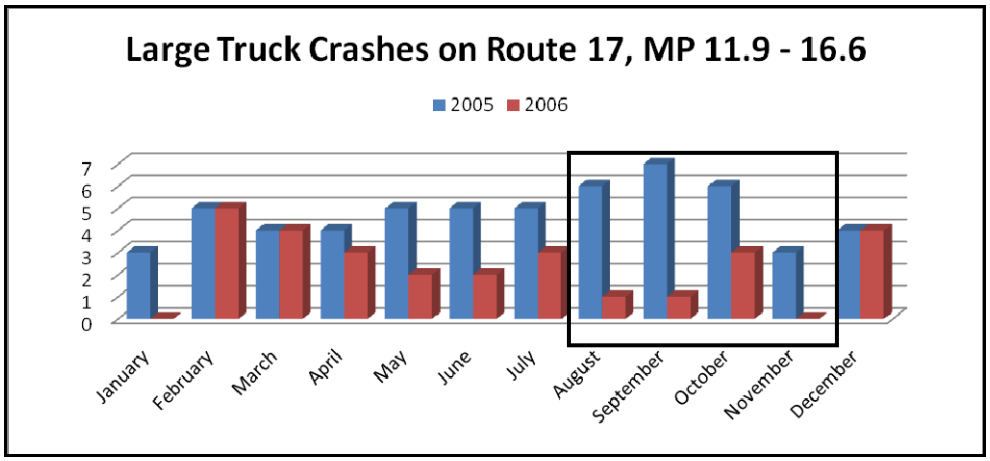
Illegal Truck Movement (Left Lane Use) Campaign Survey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)		
Marketing/Media	✓	✓
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

The major benefit appears to have been education, particularly of Canadian truckers who were found to be the most frequent violators of this law. An interesting educational approach was used with cameras photographing the license plates of violators and follow-up educational materials having been sent to them. Roadway signs have remained on the roadway as a safety reminder for truckers not to drive in the left lane.

Further Recommendations

Aside from conducting a review of crash data for this area, this project needs to be marketed as a best practice or a safety case study. Unfortunately, no efforts were made to continue monitoring truck usage of the left lane because the goal was accomplished. Route 17 presented a unique condition with the MPO and NJDOT participating as sponsors of the project. Similar opportunities exist for monitoring truck traffic on county roads; but support may be lacking if viable partnerships, like the Route 17 Working Group, cannot be established.



Projected Cost Benefit/Economic Impact

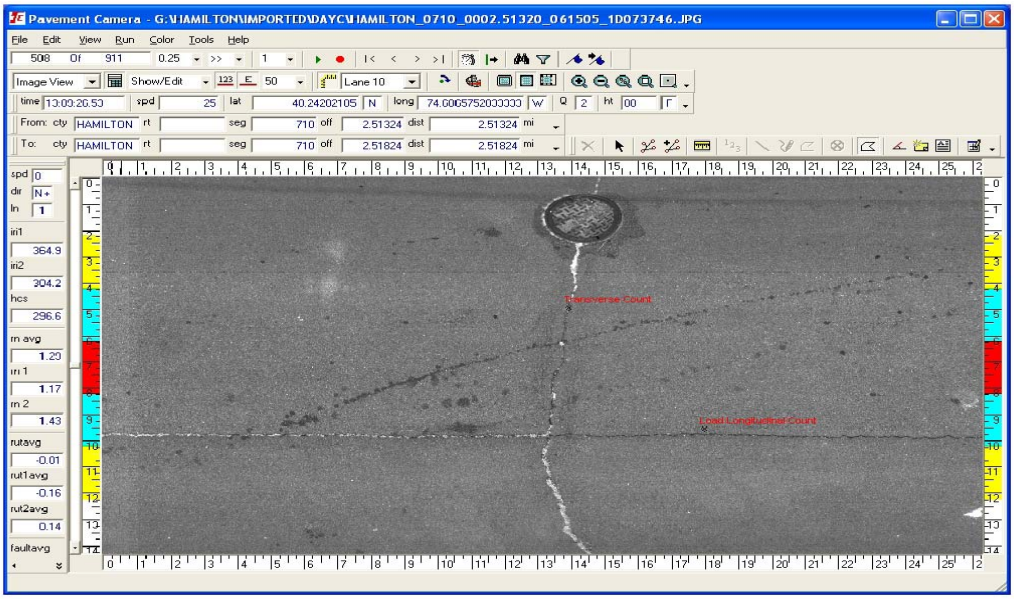
The most recent information that is available on national truck crash costs was based on 2001-2003 data and 2005 dollar costs. The Federal Motor Carrier Safety Administration calculated a series of truck crash costs that were estimated at $91,112 per crash. According to the FMCSA, there were 98 large truck crashes in New Jersey that cost $8,928,976. In Bergen County, 130 crashes increased between 2005 and 2006, at Mile Posts 11.96 to 16.54. However, the number of large truck crashes decreased by 77% from the previous year; which shows a savings of $1,548,904 that can be linked to this research project.

FHWA-NJ 2006-010: Pilot Implementation of Pavement Management Systems (PMS) for New Jersey Counties and Municipalities – Dr. Sameh Zaghloul, Stantec Consulting

Cost: $263,500 NJDOT Contribution **(**Cosponsored by MPOs).

Summary

A pilot study was conducted to demonstrate to local government the potential benefits of implementing a Pavement Management System (PMS), a systematic approach for collecting and analyzing pavement information. Six local agencies were selected representing counties, municipalities, urban, rural, large, and small communities. Performance prediction models and decision trees were developed, in addition to a budget scenario analysis that demonstrated the potential for adopting a PMS. This software showed the ability to accommodate the basic needs of local government agencies, as well as the benefits of adopting a PMS. The final products included a fully functioning PMS model that was used by NJDOT and a customized Microsoft Access version that was capable of delivering specialized reports. Although local agencies lacked the resources to implement the system, possibly the MPOs may be able to support the system for use by local agencies in their jurisdictions.



Implementation

In addition to the NJDOT, the three New Jersey Metropolitan Planning Organizations (MPOs) were project customers. The MPOs provided input on the selection of local agencies for the implementation of the Pavement Management System. Although TRB papers and presentations were not generated, a series of six reports were developed for local

agencies; as well as one publication for general distribution. A statewide workshop was held to introduce locals to the PMS system. While there was much interest in the product, cost and the collection of data to keep it current appeared to be barriers for local implementation of this system. The researchers agreed that the implementation of the PMS would greatly benefit local agencies through aesthetic enhancements of roadways, safety improvements, and cost savings over time.

Dr. Vitillo, of the Rutgers/NJDOT Pavement Resource Program, was interviewed on the outcomes of this research implementation project. The following local government agencies received technical support in the form of technology transfer or implementation tasks:

- Hamilton Township
- Jersey City
- Ocean County
- Salem County
- Union County
- City of Vineland

The technology transfer tasks included educating local government engineers on PMS concepts and benefits of the program. A series of workshops and a statewide conference was conducted for local agencies. Six PMS programs were implemented that included developing a base PMS, data collection, conducting a pilot implementation and presenting the results to the agencies for feedback.

The project was conducted with technical support from Stantec Consulting Ltd. A variety of data sources were used for PMS implementation. Depending upon the agency, field data was collected or used from existing sources to optimize the analytical process. The following variables were used:

- Surface roughness
- Surface condition (distress severities and extents)
- Rut depths
- Longitudinal profiles
- Digital video images of right-of-ways
- GPS data and coordinates of locations
- Street names
- Pavement conditions
- Pavement widths
- Construction dates and pavement layers
- Curb data

Road network conditions were evaluated in terms of the NJDOT Ride Quality Index (RQI), Surface Distress Index (SDI), and the NJDOT overall Final Pavement Rating (FPR). Two analysis tools were used that included decision trees and performance prediction models. The decision tree was used for flexible pavements and analysis, while the performance prediction models were customized to reflect the service life of pavements. A series of four budget scenarios were presented to the agency for review and consideration. This basic software was able to accommodate the PMS needs of several local agencies with limited resources. Some technical assistance may be required for data analysis and that cost may be assumed by the MPO overseeing the jurisdiction.

Pilot Implementation of Pavement Management Systems (PMS) for New Jersey Counties and Municipalities Survey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media	✓	
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Future Recommendations

Since the completion of this study, Howell Township and the City of Newark have successfully implemented the PMS program with independent resources. Future plans may include providing local support for PMS as part of the New Jersey Local Technical Assistance Program offerings.

Projected Cost Benefit/Economic Impact

The costs and benefits of pavement management were determined by Falls & Tighe (2004) as having the ability to project budgets for maintenance and rehabilitation needs, providing justification for requesting funds, measurement of effectiveness, creating improvements in the network, controlling user costs through a known level of service, upgrading safety, prioritizing projects, expanding workers knowledge of pavement needs, and reducing excessive rehabilitation cost through timely action. There was an initial cost savings of $600,000 having been realized by the six local agencies that adopted the PMS program (Vitillo, 2008). Also, an ongoing cost benefit will be realized based on the difference between the replacement value of conditions and the full rehabilitation of the roadway, which will be established over time.

FHWA-NJ 2006-013: Development of an Enhanced Emergency Locator Transmitter for General Aviation – Dr. H. Clay Gabler, Rowan University and Virginia Tech

Cost: $100,508.

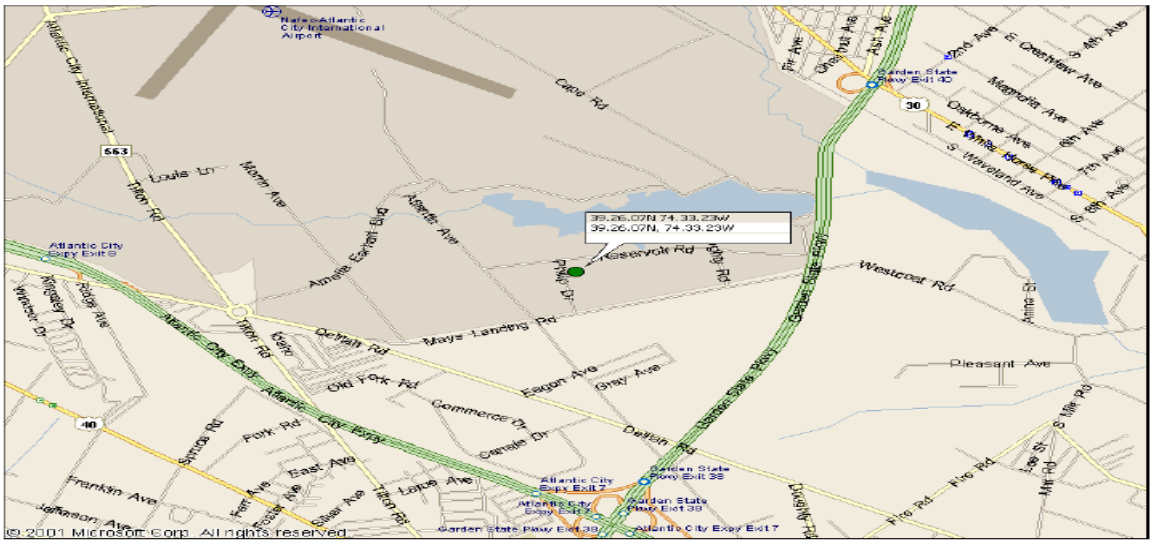
Summary

An Enhanced Emergency Locator Transmitter (E2LT) was developed for general aviation craft, in order to supplement existing systems which broadcast a simple radio beacon in the event of an aircraft crash. The E2LT transmits the crash site location and crash severity directly to Emergency Response Teams. This advanced system combined inexpensive sensors, web-enabled wireless communications and the Global Positioning Systems to transmit the crash site location to an Emergency Base Station, which resulted in a shortened response time and improved quality of response from authorities.

Over 10,000 lives have been saved worldwide, since the installation of Emergency Location Transmitters in aircrafts during the late 1970s. However, serious problems exist that challenge rescue teams for downed aircraft, which are as follows:

- False alarms,
- Failure to detect a crash, and
- Poor indication of the crash position.

The E2LT system was developed using a Mobile Unit, an installed aircraft system and a Base Station which receives distress calls from the Mobile Unit and reports the location to emergency response personnel.



This research successfully demonstrated the feasibility of the E2LT being used to enhance applications. The Mobile Unit contained a two-axis silicon accelerometer, embedded 12-channel GPS system, embedded Microchip PIC17 microcomputer, and an embedded wireless modem that was mounted on a custom printed circuit board. Also, the crash algorithm, a software module in the microprocessor, was developed to detect a crash while avoiding false alarms. In the event of a crash, the Mobile Unit and Base Station, an off-site computer laboratory, will communicate using wireless Cellular Digital Packet Data technology that allows a direct link to be established between the systems. The Base Station serves as a web server, while the Mobile Unit reports the crash to the server via a wireless internet connection. Furthermore, the high bandwidth of the web enables emergency dispatchers to handle multiple emergency requests.

Many laboratory tests were conducted during the scope of this project with the most demanding having been the testing of the E2LT in a full aircraft drop test. In July 2003, the Mobile Unit was mounted in the tail of the ATR42-300 aircraft that produced successful detection of the crash and transmission of the coordinates of the crash test site to the Base Station. In conclusion, the E2LT requires wireless towers and the ability to lock onto a sufficient number of GPS satellites; which restricts its use in remote areas of dense foliage.

Implementation

The E2LT system was developed for the NJDOT Division of Aeronautics and the Federal Aviation Administration (FAA). Primarily, a graduate student successfully completed the research and earned a Master's degree. This project provided him with extensive research experience to secure a position with the FAA. The project was initialized as part of Governor Whitman's Research Challenge and resulted in graduate students presenting their findings at the 2003 Society of Automotive Engineer's Conference. The FAA collaborated with the researchers and permitted them to test the E2LT system at their site, which proved to be successful. In 2004, the National Transportation Safety Board (NTSB) expressed interest in the project and invited Dr. Gabler and his students to present their findings to staff members. As a result, the NJDOT Bureau of Research was acknowledged for being progressive in sponsoring this innovative project. The major impact of this research was the enhanced identification of aircraft crash sites.

Enhanced Emergency Locator Transmitter for General Aviation Survey Results		
T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	
Marketing/Media (website)	✓	
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	

Bart Ritorto, NJDOT Bureau of Inspections and Aircraft Operations, confirmed that this system was the first ELT device that used cellular technology with GPS tracking. Although the device can accurately pinpoint the location of a crash for faster rescue, there is limited benefit for use in New Jersey due to the area being so densely populated that crash locations are immediately obvious. Also, in remote areas where there is no cellular phone service, the device will not work. The major obstacle to implementation is that there must be FAA approval for replacing the current permanently mounted device on aircraft. This effort would require funding and time to accomplish FAA certification and approval.

Future Recommendations

If the device were modified by the private sector to become portable and less expensive, pilots would be interested in using it to supplement the existing Emergency Locator Transmitter. Pilots could purchase their own device and use it in any small aircraft, as they often do with carbon monoxide detectors. Portability is an important factor because many pilots rent and do not own planes. Advanced cellular technology and more complete cellular coverage would make this device more attractive. Time and labor savings would be realized during a rescue operation, while there is the safety potential due to quicker rescues. Additional research is important to the aviation industry, so NJDOT Bureau of Inspections and Aircraft Operations will continue to work with NJDOT Bureau of Research in supporting mutual research efforts.

Projected Cost Benefit/Economic Impact

All too frequently, plane crash victims die while waiting to be rescued because their plane's ELT does not work properly. While flying from California to Narobi, Kenya; Bill Cox (Plane and Pilot, 2008) reported that his plane had crashed and the installed ELT did not work, but the portable one had saved him and a fellow passenger from the heat of the dessert. Although not quantifiable, quicker rescues increase the chances of saving lives of those involved in a plane crash.

FHWA-NJ 2006-014: Diesel Emission Reduction Strategies for School Buses and HDDV Trucks – Dr. Robert Hesketh, Rowan University

Cost: $1,000,000 NJDOT Contributions (Cosponsored).

Summary

The purpose of this research was to develop strategies for reducing diesel emissions from mobile sources, such as school buses and Heavy Duty Diesel Vehicle (HDDV) trucks that result from accommodating driver comfort. A comparison of alternatives to idling was done showing reductions in overall emissions. These solutions included alternative fuels and after treatment devices. Also, a Life Cycle Analysis of HDDV Idle Reduction Technologies was developed as part of this research project. The findings showed that the most significant reduction in emissions for school buses was obtained using ultra low sulfur diesel with a diesel particulate filter, but this reduction was minimal.

A test was conducted to quantify the idling emissions and fuel consumption rates for HDDVs. Testing of eight truck models, produced between the 1990s and 2001, was performed in an environmental chamber to simulate a variety of idling situations. The results showed that one truck idling for eight hours consumed approximately 10 gallons. Two Alternative Power Units were tested to replace an idling truck engine. The Espar Heater consumed 95% less fuel and emitted 99% less NOx emissions. The Pony Pack testing showed an 80% fuel reduction, but no changes in the NOx.

Another test, conducted at the Aberdeen Test Center, examined school bus idling. Three school buses were idled in four temperature conditions. The average fuel consumption was 0.5 gal/hr. The results showed that NOx emissions ranged from 40-80 g/hr for International engines and 50-110 g/hr for Cummins ISB engines. Alternative fuels were also used to test school bus mobile emissions. Actual route data were collected from five different school districts to develop the Rowan University Composite School Bus Cycle (RUCSBC) that amounted to one 12 minute run. Four fuel configurations were tested:#2 diesel-20% biodiesel, 80% #2 diesel; ultra-low sulfur diesel, and 20% biodiesel/80% ULSD. Alternative fuels actually provided minimal reductions in emissions with the best fuel being 20% biodiesel/80% ULSD fuel. When comparing the results to the 2007 EPA standards, the use of alternative fuels alone did not provide enough reduction in emissions to meet the standard.

After treatment devices were then employed during the second phase of testing. The devices were retrofitted to the school bus and three tests were performed using the RUCSBC. The results indicated that the use of after treatment devices reduced CO and HC to below the EPA limit. Diesel particulate filters also reduced the particulate matter of the 2007 standard. However, NOx emissions were not reduced significantly, so additional strategies had to be investigated further.

Since particulate matter concentrations were found inside school bus cabins, a study was conducted to measure particulate matter as a function of speed. The results showed that the bus speed had the largest impact on mean particle

concentration inside the school bus, while the position of the windows affected particle concentration. At idle, the concentration inside the bus was lower than the background concentration when the windows were closed.

Additionally, an economic analysis of heavy-duty diesel vehicle idling alternatives was examined. This study was important because HDDT drivers are required to rest eight hours for every 10 driving hours, so trucks were idling for long periods of time. Several technologies were identified as alternatives that included heaters in the vehicle, auxiliary power units, parking space electrification, plus adding heating and air conditioning units in parking spaces. Truck Stop Electrification proved to be the most beneficial for truck drivers, based on a fee of $1.25 per hour of use.

Implementation

In addition to identifying cost effective solutions for saving fuel and reducing pollution from school bus and HDDT emissions, this project enabled 12 undergraduates and 4 graduate students to conduct research on solving transportation and environmental problems. Also, three Master's level research studies and a series of presentations were conducted on behalf of NJDOT (i.e. Society of Automotive Engineers (SAE), AlChE, and the Combustion Institute). Also, a total of six additional research papers were published between 2003 and 2005, at the SAE World Conference.

Diesel Emission Reduction Strategies for School Buses and HDDV Trucks Survey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	
Marketing/Media (website)	✓	
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Before retirement, Henry Schweber managed this project, which began as a study on diesel emission reduction and evolved into diesel emission from school buses. This research effort was initiated in 2001 and continued for a six year period. The final phase of the project was of little value to the Air Quality Unit, since it focused on school bus emissions. A series of research papers were produced on bus testing cycles, a corresponding mathematical model for predicting emission reductions of school buses and HDDV had been developed for use, and a website was created for school districts interested in retrofits and other bio-diesel fuel options for their current bus fleet. Cost and location of products were included in this site.

Future Recommendations

As a result of the research findings from Rowan University, a diesel emission reduction project was independently installed by the Department of Environmental Protection (DEP) at the Paulsboro truck stop located in Gloucester County. This affordable alternative to diesel idling supports the reduction of harmful soot in the air. A console is mounted on the cab's passenger window that delivers heat, ventilation and air conditioning to the cab. Additional hookups are available for cable television, telephones, and internet services. The Paulsboro Truck Stop project has been showcased as a great example of government and private enterprise working together to help save the environment.

Projected Cost Benefit/Economic Impact

Air pollution is considered an external transportation cost, although the emissions tend to be dispersed near people and are very damaging. Regulatory requirements have helped to reduce the pollutants, but they still remain in areas where vehicles travel. As noted in this study, the goal of the researchers was to reduce diesel emissions from mobile sources

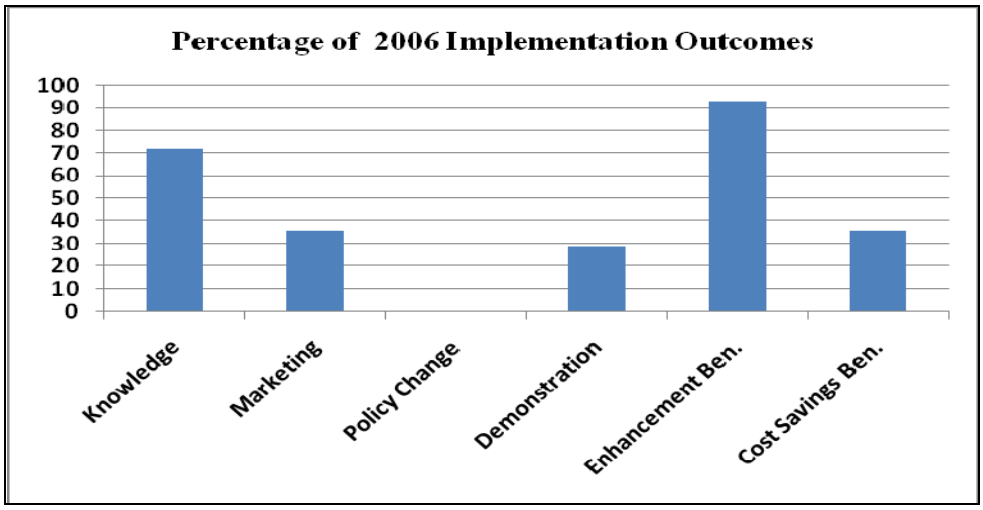
such as school buses and HDDV trucks, in order to meet the 2007 emission standards. When determining a cost benefit ratio for the project, there were limitations due to kilograms being used in conjunction with tonnage measures and the unspecified number of vehicles being measured. Another opportunity existed to identify the strategies that were in compliance with the pending emission standards. Two proved to be most effective in reducing pollution caused by idling trucks (Table 9). The truck power pack and the electrification unit served as countermeasures that netted cost savings of $1.50 per gallon of fuel, while the electrification unit had a payback rate of 1.53 for the driver and 1.16 for the rest area. In the future, these calculations need to be adjusted for inflation and applied to HDDVs and buses that are seeking compliance with the 2007 emission standards.

Acceptance of Measurements for Compliance with the 2007 Emission Standards

Measurement	Results	Compliance with 2007 Standards
HDDV Idle Emissions	Alternative Power Unit: Espar Heater (95% less fuel and 99% less NOx emissions.)	✓
Effects of School Bus Idle Emissions	An average fuel consumption of 0.5 gal/hr for idling buses. NOx emission ranged from 40-80 g/hr for the International engines and 50-110 g/hr for the Cummins ISB engine.	
Effects of Various Alternative Fuels on School Bus Mobile Emissions	Five alternative fuels were tested with the fuel containing 20% Biodiesel/ULSD performing the best, but not reached the 2007 EPA standards	
Effects of After Treatment Devices on School Bus Mobile Emissions	After treatment devices require the use of ULSD fuel that was previously tested during the alternative fuel study. Results show the use of a DPF will eliminate over 95% of particulate matter. It conformed the PM to the 2007 standards but did not reduce NOx emissions.	
Particulate Matter Levels Inside a typical NJ School Bus Cabin	Bus speed had the highest impact of particle concentration inside the bus. The position of the window gave high particulate concentration averages. Also the relationship of the window and the speed impacted the concentration of particles in the bus cabin.	
Conduct a Life Cycle Analysis of HDDV Idle Reduction Technologies	Truckers idle for several hours and emit gaseous particulates. Truck stop electrification showed the most benefit to the truck drivers and the State.	✓

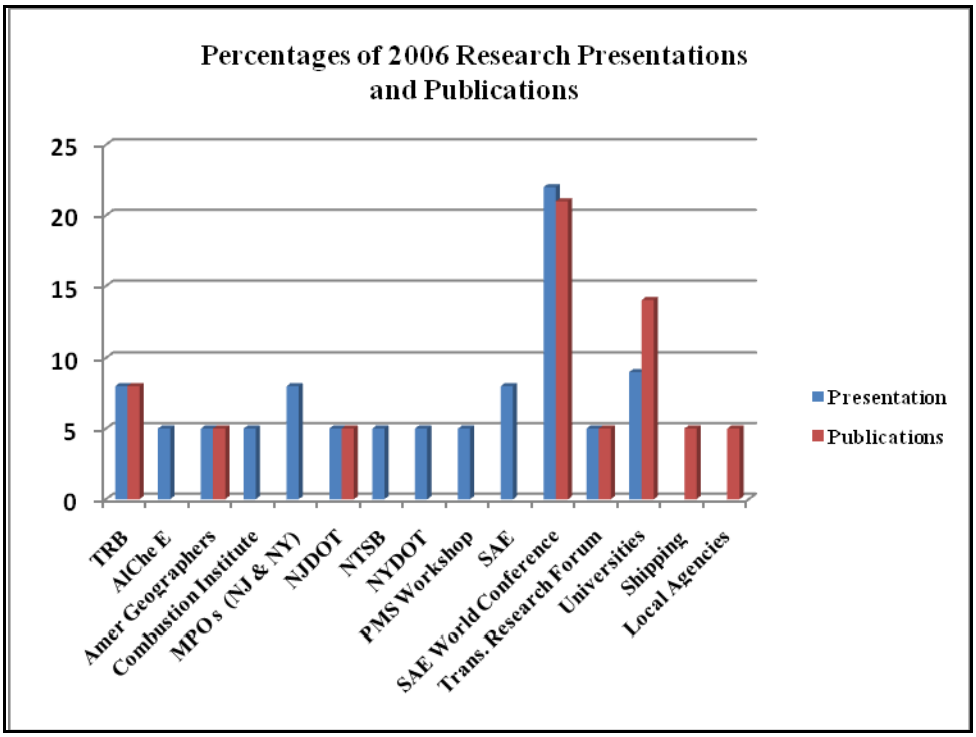
Summary

The purpose of this implementation follow-up study was to identify technology transfer measures that contribute to the enhancement and cost savings of transportation research. According to TRB (1999), the four stages of the technology transfer process include awareness (knowledge transfer), attitude formation, persuasion (marketing), trial and decision making (policy/procedure/process change), and confirmation (demonstration). These technology transfer measures and implementation benefits were described by both the researchers and customers.



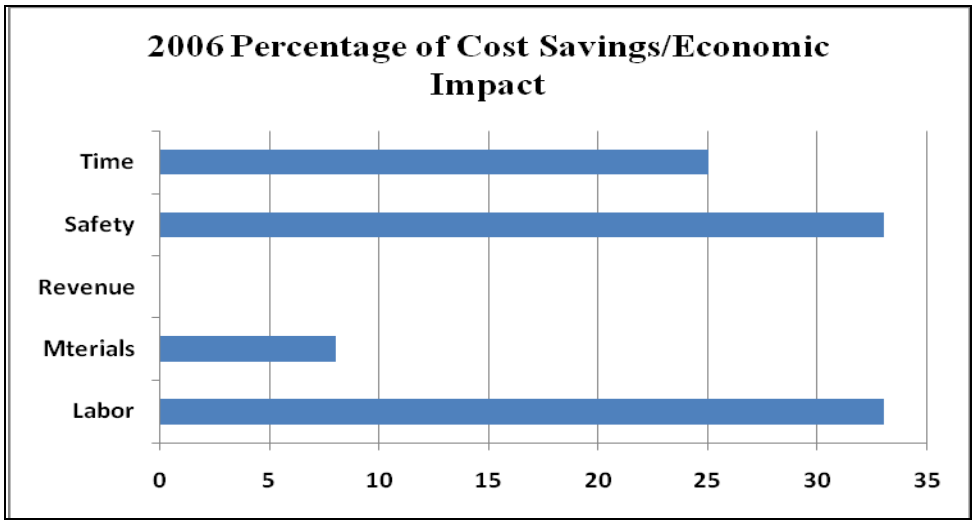
Knowledge Transfer: After the research projects were completed and accepted by NJDOT, over 70% of researchers conducted 22 presentations and wrote 21 publications that were distributed throughout the United States and in Europe. Two studies had been accepted at the Transportation Research Board (i.e. Evaluation of Adaptive Control Strategies and Empty Intermodal Container Management); while the remaining research was accepted by the Society of Automotive Engineers. Three Master's thesis studies were produced in conjunction with the NJDOT sponsored research and one study was even presented abroad at the University of Antwerp. Furthermore, the New York Department of Transportation benefited from the Balsi Beam project and they planned to fabricate it themselves. Also, the National Transportation Safety Board requested a special presentation on the E2LT system, a project that they may consider adopting. It was difficult for any of the researchers to identify additional benefits generated by their projects, except for the opportunities that were presented to their graduate students. Rowan University acknowledged that three students obtained their Master's degrees while working on the research project. Also, the E2LT activities provided another graduate student with enough experience to be recruited by the Federal Aviation Administration.

Marketing/Media: Marketing of products and safety strategies played an important role in the promotion of project enhancements for 36% of the interviewees. First, signage was used in the Route 17 study to get the truckers to leave the left lane. The benefits of PMS had been marketed to local users at a statewide conference, while a website posted information on retrofitting school buses with emission control systems. The E2LT system was promoted at the NTSB.



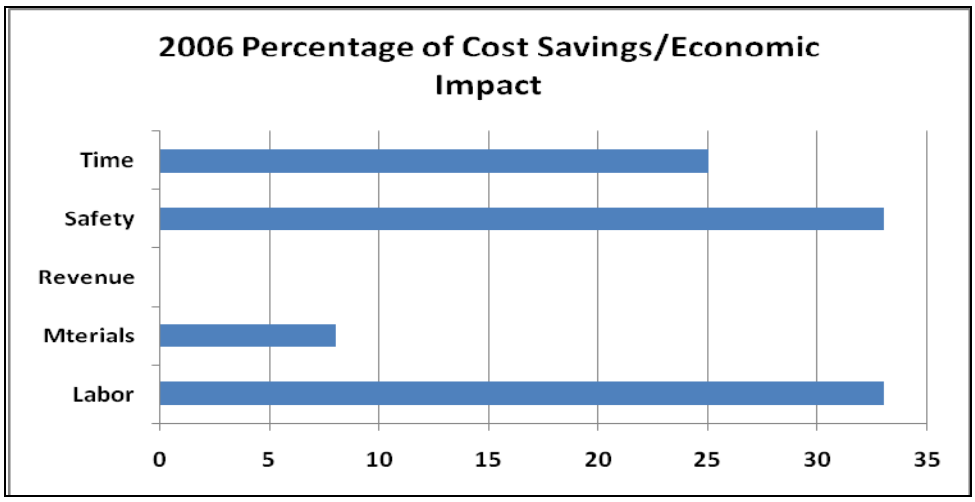
Demonstrations: The use of demonstrations was reported by three researchers. The decision support system for adaptive control strategies was developed and piloted by NJDOT staff members, who have since retired from the agency. Demonstration projects validated the ability of local agencies to use a basic PMS system to meet their roadway maintenance needs. Also, a test was conducted using the E2LT system to prove its crashworthiness.

Enhancement Benefits: Nearly all of the respondents (93%) identified enhancement as a benefit of the research studies. (See the table below.) Approximately half of the projects improved efficiency for the researchers and customers, which was equipment that reduced labor output (e.g. computer based tools to improve service). The table shows that three studies enhanced the environment and all projects were viewed as improving worker and roadway safety. Also, equipment was developed for all of the projects, except the Balsi Beam that was being evaluated for use in New Jersey. This equipment ranged from computer-based tools to roadway devices for protecting workers.

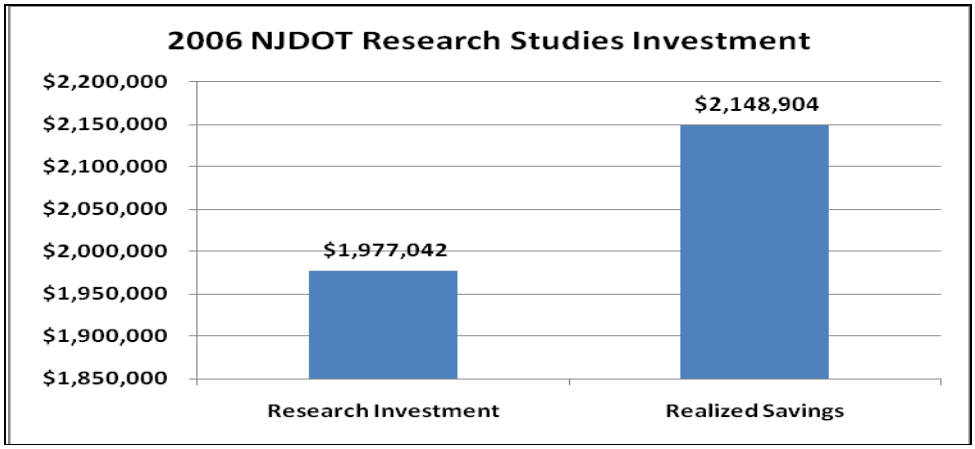


Cost Saving/Economic Impact Benefits

The most important impacts of these projects were the potential for reduction of crashes and severe injuries, along with increased roadway mobility, and improvement of the environment. Cost benefits have already been realized through the Pavement Management Systems and Illegal Truck Movement projects; while the remaining studies have the potential to yield significant returns of over $20,000,000 based on improvement of safety, labor reduction, and addressing environmental issues.



Only one sponsor was able to identify the cost of saving lives and reducing crashes. As shown in the following table, over half of the respondents (57%) reported savings in labor, while time savings was also realized by this group. Other cost savings were based on the methodology supported by the European Road Safety Observatory (2006). After measures had been developed to reduce a problem, the impacts were described through referenced scenarios and estimates of the impact(s). After the impacts of each program had been identified in natural units, then cost estimates were obtained to determine the value of the research project.



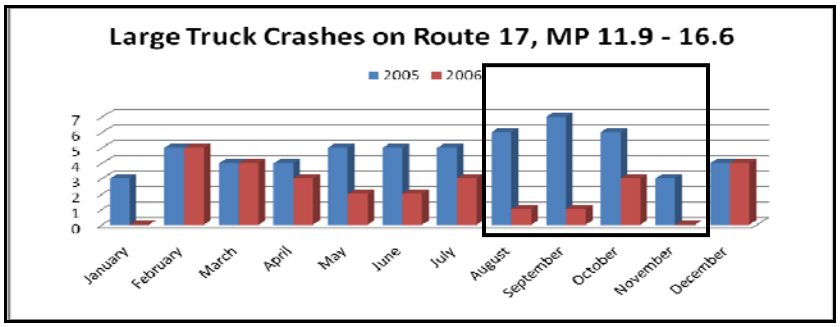
When comparing the research investment of $1,980, 000 to the realized savings, $2,150,000 just two years later has been based on the reduction of truck crashes and the provision of technical services to municipalities. Also, potential

savings have been identified at $20,000,000 over the course of (several years) time, but conditions must first be met that include additional investments by the NJDOT to fully implement projects on a statewide level.

NJDOT Realized Savings

The project, Development and Implementation of an Awareness, Education, and Enforcement Campaign Regarding Illegal Truck Movement Along Route 17 in Paramus, NJ, determined to what extent trucks were traveling illegally in the left lane on Route 17, located in Paramus. Next, test methods were developed to alleviate the problem. Also, a series of partnerships were formed between local enforcement, a New Jersey State Senator, the NJDOT, and NJIT to develop and support solutions to improve safety conditions on this roadway. Safety improvements were accomplished through the use of technical instruments to capture the extent of the problem and then develop educational resources to address the issue.

Currently available information on national truck crash costs was estimated at $91,112 per crash. In Bergen County, 130 crashes increased between 2005 and 2006, at Mile Posts 11.96 to 16.54. However, the number of large truck crashes decreased by 77% from the previous year; which had shown a savings of $1,548,904 based at the time of the research activities.



Source: *Rutgers, TSRC, 4/08.*

County and Municipal Realized Savings

In addition to the NJDOT, the three New Jersey Metropolitan Planning Organizations (MPOs) were project customers. The MPOs provided input on the selection of local agencies for the implementation of the Pavement Management System. The following local government agencies received technical support in the form of technology transfer or implementation tasks:

- Hamilton Township
- Jersey City
- Ocean County
- Salem County
- Union County
- City of Vineland

The technology transfer tasks included educating local government engineers on PMS concepts and benefits of the program. A series of workshops and a statewide conference was conducted for local agencies. Six PMS programs were implemented that included developing a base PMS, data collection, conducting a pilot implementation and presenting the results to the agencies for feedback.

Road network conditions were evaluated in terms of the NJDOT Ride Quality Index (RQI), Surface Distress Index (SDI), and the NJDOT overall Final Pavement Rating (FPR). Two analysis tools were used that included decision trees and performance prediction models. The decision tree was used for flexible pavements and analysis, while the performance prediction models were customized to reflect the service life of pavements. A cost savings of $100,000 for the development and installation of each PMS system was realized by each of the six agencies.

Conclusion

When comparing the research investment of 1,970, 000 to the realized savings, the $2,150,000 return has been based on the reduction of truck crashes and the provision of technical services to municipalities. A total of $180,000 has been returned to NJDOT in savings. Also, potential exists for a $20,000,000 return to NJDOT over the course of (several years) time, but conditions must first be met that include additional investments by the NJDOT to fully implement projects on a statewide level.

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ATTACHMENT A

Project Title:

FHWA Project Number_____ Start Date:_____ Completion Date:_____

Principal Investigator: _____ University/Consultant:_____

Bureau of Research Project Manager:_____ Customer/Unit:_____

Implementation Follow Up: 1 year ___ 2 year___ 3 year ___

Implementation/T2 Measure			**Est. Cost**	**Champion**	**Completion Date**
Knowledge Transfer	Findings/Report Dissemination	☐			
	Seminar	☐			
	Training	☐			
Marketing/Media	Brochure/Publication/article	☐			
	Electronic Media/Website	☐			
Policy/Procedure/Process Change	Admin/Process/Procedure Change	☐			
	Policy Change	☐			
	Specification/Standard Change	☐			
Demonstration	Pilot Project	☐			
Implementation Benefits					
Enhancement	Aesthetic	☐			
	Efficiency/Effectiveness	☐			
	Environmental	☐			
	Safety	☐			
Cost Savings/Economic Impact	Equipment	☐			
	Labor	☐			
	Materials	☐			
	Revenue Increase	☐			
	Safety	☐			
	Time	☐			
TOTAL					

How useful were the research findings/products/outcome? The research study resulted in:

☐implementable **changes** with **quantifiable benefits. Please Specify:**_____

☐implementable **changes** with **no quantifiable benefits. Please Specify:**_____

☐**knowledge** transfer with **no quantifiable benefits. Please Specify:**_____

☐no implementation. Explanation:_____

Can the Bureau of Research or NJ LTAP provide further assistance in implementing the findings of the study?
Yes ☐ No ☐ Comments: