March 2008

ANALYSIS OF TRANSPORTATION SERVICES FOR A PACE PROGRAM

Joseph L. Grollman  
*Worcester Polytechnic Institute*

Kevin Euri Wayns  
*Worcester Polytechnic Institute*

Vannak Chhay  
*Worcester Polytechnic Institute*

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ANALYSIS OF TRANSPORTATION SERVICES FOR A PACE PROGRAM

A Major Qualifying Project Report

Submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

in Mechanical Engineering

by

Vannak Chhay

Joseph Grollman

Kevin Wayns

Date: February 28, 2008

Approved:

Professor Sharon Johnson, Major Advisor
Authorship

This report represents the collective work of all parties involved; however specific sections were authored by specific group members and this authorship statement will outline the party responsible for all sections.

- The introduction section authored by Joseph Grollman, with revisions by Vannak Chhay
- The Background section completed collectively by all members with subsections assigned to group members. The PACE related sections were authored by Joseph Grollman; Transportation Services and Grants Information sections were authored by Vannak Chhay; and Frail Elder Care section authored by Kevin Wayns.
- The Methodology section was authored by Joseph Grollman, with Capstone Design developed by Kevin Wayns
- The analysis in the Transportation Services sections was led and authored by Vannak Chhay, with figures produced by Kevin Wayns. Policies and Procedures Related to Transportation Services were developed and authored by Kevin Wayns and Vannak Chhay.
- The transportation model development was led and authored by Joseph Grollman with sensitivity analysis by Vannak Chhay, and model layout by Kevin Wayns.
- The conclusions development authored by Joseph Grollman, with future considerations by Kevin Wayns and revision by Vannak Chhay.
Abstract

Analysis is undertaken to determine the overall feasibility, operational and business implications of insourcing transportation for a New England-based Program of All-inclusive Care for the Elderly (PACE). On-site analysis, data analysis and independent research combine to produce an extensive model for examining the costs of insourcing under various scenarios. Based on current estimates, it is not recommended that insourcing occur as the desired cost per member per month cannot be met.
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Acknowledgements

Our group would like to thank everyone at the New England-based PACE program. In particular we would like to thank the Director of Operations, Senior Financial Analyst, and Executive Director for being instrumental in our weekly meetings to develop this project and the Division President of Senior Care and Living, for his input in our planning process. At the specific sites we would like to thank the site directors, transportation coordinators, and staff, for their aid in conducting and planning our site visits. We would like to thank Professor Sharon Johnson for being an excellent project advisor. Professor Johnson’s knowledge and experience has helped us shape our general project ideas into a cohesive plan of action.
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1. Introduction

A New England-based Health Plan (NEHP) is unique in that it is both a provider of insurance and administers care. The product offerings cover “a variety of group and non-group health plan options (HMO, POS and PPO, as well as Medicaid and Medicare Advantage plans)” as well as a wide variety of programs and services to keep members healthy and well throughout their lives. As an example of such programs, NEHP provides care to seniors via an alternative to standard nursing home care, enabling them to live at home and receive needed services. (NEHP Biographical)

In order to deliver timely and cost-effective transportation solutions to their growing customer base, a New England-based PACE program must manage both costs and overall transportation policies. To further these goals, a transportation study has been commissioned with the dual objectives of evaluating the existing transportation system with a focus on mitigating inefficiencies and examining the potential merits of insourcing any or all of the transportation solution currently provided by existing vendors. The study has two major aspects; an in-depth examination of the existing transit system and a detailed analysis of the insourcing decision. Key performance metrics for a transit system are timeliness (on time pickups/drop offs) and time in van (total transit time), both of which are sources of complaints, as well cost per member per month. Other important areas to explore are shown in Tables 1 and 2:

<table>
<thead>
<tr>
<th>Table 1: Areas to Explore in the Transit System</th>
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<tbody>
<tr>
<td>Analyze whether there are more effective ways to load/unload at the start/end of the day</td>
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<tr>
<td>Analyze existing routing procedures</td>
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A cursory glance at the transportation problem faced at a New England PACE Program may suggest that it is a simple numerical problem. The division, New England-based Program of All-inclusive Care for the Elderly (PACE) has increased rapidly with revenue that more than doubled from $10 million to $24 million over the past 4 years. Transportation expense is among one of the top expenses of this program. PACE programs in general are designed according to the idea that frail seniors will be healthier and happier if they are able to remain in their own homes and communities as long as possible. (New England PACE)

Coincidentally, although few in number, the main area of complaint is also transportation, and the New England PACE program would like to improve satisfaction ratings for time in van and timeliness. There is a trade off between customer satisfaction and costs that must be examined. How can an expanding business reduce costs while improving timeliness to increase profitability while also maintaining customer satisfaction?

The Division President of Senior Care and Living has expressed an interest in examining the feasibility of insourcing all or part of a New England-based PACE program’s transportation needs. Insourcing is the delegation of a particular task to an internal entity. In this case, insourcing would involve the creation of a division of transportation and logistics within NEHP to service the company’s daily logistics needs which are currently handled by external vendors. On the other hand, outsourcing is the delegation of a particular task to an external entity. For example, contracting with a third party transportation company to provide transportation for

<table>
<thead>
<tr>
<th>Table 2: Areas of Analysis of the Insourcing Decision</th>
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<tbody>
<tr>
<td>Look at existing cost structures to see if better coordination can be undertaken to reduce costs.</td>
</tr>
<tr>
<td>Develop a Scoring Model to weight costs and benefits/service levels</td>
</tr>
<tr>
<td>Examine existing vendor relationships</td>
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participants in the PACE program would be considered outsourcing because the task is being delegated to another company.

The project had two goals initially, first to conduct an operational analysis of current transportation, and second to develop a business case for insourcing. We began evaluating the sites and identifying ways to improve customer satisfaction by reducing time spent in transit. Other areas that we planned to be explored are shown in Table 1. These areas were not explored for two major reasons: first, the project sponsors wanted to refocus the project on insourcing, and second, the project sponsors wanted the change to be incorporated quickly. This caused us to focus primarily on to cost modeling/forecasting as opposed to exploring process improvements further. This refocusing reflects real world projects and changing requirements.

As a result of the change in focus, we explored all areas in Table 2 and created several models for analysis. These models show cost associated with various scenarios, the weight the sponsor company places on different parts of the transportation service, and the effects of service on cost. The cost tool was designed to be easy and robust enough to enable the PACE program to estimate the costs and benefits associated with future transportation needs beyond the timeframe of this project. Inputs can be refined and the overall outputs will help determine what level, if any, of insourcing would be feasible for consideration.

The following sections present our project by first introducing relevant information for context and direction before going into results. Background information in Chapter 2 is given in the beginning so that the reader may understand the constraints and environment of our project. Then an explanation of our methodology is given in Chapter 3. This chapter provides the reasoning for why we went about the project the way we did so that in later chapters the reader may better understand our decisions. Next in Chapter 4, our work on the operational side of the
project is presented. This serves to inform the reader in the initial and overall reasoning of the project, which is to improve service to the end user. Finally, our models and results are presented in Chapter 5 after context has been provided, and our conclusions and recommendation in Chapter 6.
2. Background

In order to understand the meaning behind our project and the consequences of any results, we introduce relevant background information on the subject matter here. Their information sheds light on what a New England-based PACE program’s concerns are and how our project seeks to address these concerns. In addition, the background information serves to bind the scope of this project. There are a variety of ways the project may have gone about solving the needs of a New England-based PACE program. An entire study on customer satisfaction and effects of stimulus on vans to reduce perceived wait time, a study on insourcing and its dilemmas and successes in terms of Elder Care transportation services, a business case study on the viability of a for profit business in transportation, and many others could have been explored. However, the needs for a particular solution given by company and the regulations governing the PACE programs have led us to undertake the project in the manner we did.

In the following section we discuss general information that serves to clarify our project. An overview of PACE programs, the New England-based PACE program sites, the current transportation services and the elder care is given because this information help in identify the need of this project.

2.1 PACE Programs

A New England-based health plan offers a Program of All-inclusive Care for the Elderly (PACE). PACE programs in general are designed according to the idea that frail seniors will be healthier and happier if they are able to remain in their own homes and communities as long as possible. (New England PACE)

The service arrangement would later develop into PACE originated in San Francisco in the 1970s. Immigrants living in Chinatown wanted an alternative to traditional nursing homes
that would enable the elderly to stay at home. No existing service offering met this criteria and a nonprofit organization, On Lok Senior Health Services, was established in order to meet the medical needs of the elderly in the community. It is from this organization’s effort that the current PACE model is derived. (New England PACE)

The initial efforts were highly successful and a grant was awarded from the U.S. Department of Health and Human Services in order to attempt to design deployment methods to rollout this sort of service offering to other regions. For example, A New England state, with its general focus on the welfare of its citizens pioneered PACE programs, leading to the establishment of different programs throughout the state. Nationwide, there are over 40 pace programs. (National PACE) NEHP is a PACE provider offering Program of All-inclusive Care for the Elderly.

Those eligible to participate in a PACE program are: “Individuals who are age 55 or older, certified by their state to need nursing home care, are able to live safely in the community at the time of enrollment, and live in a PACE service area.” (National PACE) This represents an interesting dichotomy as the seniors are “certified to need nursing home care to enroll in PACE, only about seven percent of PACE participants nationally reside in a nursing home” thus enabling the participants to receive care while remaining in a comfortable environment.

PACE program coordinators and interdisciplinary teams work closely with participants and caregivers to achieve PACE goals. This care includes prescription drug coverage, doctor and/or specialist visits, unlimited therapy visits and access to Adult Day Health Centers. Adult day health center helps keep participants connected and involved in their well being and the health of their fellow participants. NEHP employs physicians, nurses, specialty doctors, and staff to handle participant’s needs efficiently. (New England Benefits)
2.2 New England-based PACE program

A New England-based PACE program is fairly typical of a PACE program, offering full coverage for the services shown in Table 3 to qualified participants in surrounding counties.

<table>
<thead>
<tr>
<th>Care Options Offered</th>
<th>Services Offered</th>
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<tbody>
<tr>
<td>Physical, Occupational, Recreational and other Therapies.</td>
<td>24-Hour Telephone Access to a Member of the Participant's Geriatric Team</td>
</tr>
<tr>
<td>Adult Day Health Care Services for Cognitive and Cognitively Impaired individuals</td>
<td>Geriatric Consultation and Support for Participants and their Caregivers</td>
</tr>
<tr>
<td>Specialty Care Services such as Cardiology, Ophthalmology, Podiatry</td>
<td>Unlimited Prescription Drug Coverage</td>
</tr>
<tr>
<td>In-Home Assistance with Personal Care Needs such as bathing, dressing, and meal preparations as needed.</td>
<td>Transportation to and from the New England-based PACE program Adult Day Center</td>
</tr>
<tr>
<td>In-Home Nursing, Rehabilitation and other Medical Services as needed.</td>
<td>Other Services as prescribed by the interdisciplinary team</td>
</tr>
<tr>
<td>Dental and Vision Care including Eyeglasses</td>
<td>Laboratory, Diagnostic Testing</td>
</tr>
<tr>
<td>Personal Primary Care Team</td>
<td>Nutrition Evaluations and Guidance</td>
</tr>
<tr>
<td>Inpatient Hospital Care</td>
<td>Medication Management</td>
</tr>
<tr>
<td>Nursing Home Care</td>
<td>Medical Supplies and Equipment</td>
</tr>
</tbody>
</table>

Transportation is a key part of PACE programs, as it enables the elderly to maintain primary residence in their homes while having access to general and specialty medical care as well as social activities. New England-based PACE program differs from most other PACE programs in that it services a wider geographic area spanning a 31 miles radius around the first site location with border to border service areas spanning a distance from 50 to 80 miles according to 2005 service area estimates, as opposed to metropolitan areas serving a 17 mile radius. (National PACE) As a result of this, the customer density is low. This causes both transportation expenses and transportation times to be higher per customer than for other programs.


2.3 Transportation Services

Several problems arise in establishing a new service or deciding on a new model of service. The New England-based PACE program’s original model for transportation services was a completely outsourced one. Due to growing volatility with vendor renegotiations and rising prices, NEHP wanted to explore alternatives to the current mode. For a solution that involves insourcing a comprehensive door-to-door transportation system, financial barriers occur due to several factors. The inefficiencies are due to lack of expertise in the field, lack of volume in terms of number of trips daily, and lack of leverage in terms of purchasing power and established infrastructure for maintenance and storage of the vehicles. In the following paragraphs, we will examine door-through-door transportation, dial-a-ride services, and a study on what forms of transportation seniors utilize.

The first example, “How to Establish and Maintain Door-Through-Door Transportation Services for Seniors” (Burkhardt and Kerschner, 2005) discusses current door-through-door transportation services and how they operated. The article reviews different service types, options on how to start the operations and grow it, and offers answers to frequently asked questions.

Door-through-door services, which consist of providing seniors the help they need to get from door of their house to the van and then the van to the facility, are necessary for several reasons. For one, some seniors are frail and infirm and need the added assistance, the service responds to special personal needs and allows the person to retain some independence, and the senior population is expected to double from 2000 to 2030. All of these reasons are already accounted for at the New England-based PACE program. The PACE program helps to provide independence to the seniors and thus the transportation service reflects this goal. The alternative
to a door-through-door service is to provide just enough support. For instance, gentle support for those elders that are still very able would consist of opening doors and verbal guidance.

Studies of Bedford Ride located in Virginia, Gadabout in New York, Kaunoa Senior Services in Hawaii, Ride Connection in Oregon, West Austin Caregivers in Texas and TRIP in California revealed some very useful information. Two out of the six programs used driver-owned vehicles, while four out of six used either driver-owned or a combination of driver-owned and program’s vehicle. Only two out of six of the programs used 100% program vehicle. By using vehicles that are owned by the drivers, the programs do not incur a large capital costs and may be able to better justify such a transportation program. Furthermore, six out of the six programs used volunteers as drivers whether it was in conjunction with paid drivers or just simply volunteers only. By using combination of volunteers and driver-owned vehicles, the two largest segments of transportation cost can be cut drastically. (Burkhardt and Kerschner, 2005)

After having defined service, Burkhardt and Kerschner suggest that the key to success for a program is to work closely with a partner. By this, they mean that it should obtain financial support from local or federal agencies. The other recommendations for running and growing the program include: train the drivers well, focus on efficiency, keep the service individualized, have enough financial support, add value to the community, be adaptive and to build a strong consumer-oriented service. (Burkhardt and Kerschner, 2005)

Moving on, the Dial-a-Ride service is defined as providing transportation for users given a specified time window, maximum ride time for the passenger, and the vehicles depart from and arrive at a common depot. The objectives are to minimize total service cost, maximize the convenience on passengers, and to maximize the number of users. Although, a transportation software in all likelihood will handle this process, it is important to understand the process itself
and how it works. This serves to either provide a basis for more optimal use of the software or an understanding of the process such that one may see the failures and limitations of the software.

The multi-dimensional issues of passenger requirements and vehicle types are addressed by a modified parallel insertion algorithm. (Bell, 2006) The algorithm takes into account several important factors that relate to our study at the New England-based PACE program. Many variables that are taken into account form ranges of acceptable time. For example, it takes into account earlier pickup time of request and latest pick up time of request. This gives a specific time window so that the customer wait time can be controlled. The other factors that are taken into account are distances to and from the location and origin, ride and load times and user type, whether the user is walking or in a wheelchair.

The service is a very demand responsive and fits well to the needs of elder care transportation. When combined with a centralized communication system that connects users, facilities and drivers, Dial-a-Ride can provide the service level required for the minimum total costs.

In short, the equation shown below in Figure 1, multiplies a positive weight beta, \( \beta \), with the trip characteristics---user type, \( r_i \), earliest pick-up time, \( EPT_i \), loading and unloading time, \( p_i \) and \( q_i \), and a decentralized distance for the trip, \( d_i \). The output of this equation is the difficulty degree, which measures the difficulty that the request causes to other requests. By minimizing how new requests adversely affect the current trips, the model maximizes efficiently and overall service level. However, the equation below does not take into account how van sizes and the addition of trips to an existing one affects the system.
Another important alternative that arises from this article is the combination of minibus and taxis to serve total customer demand more efficiently. The current insourcing model does not take into account the possibility of using taxis for smaller trips or trips that add an undesirable amount of time to other passengers. By contracting with a taxi company, the cost of van purchase and the service level may both improve. (Bell, 2006)

A focus group in New York had the objective of asking the elders how they travel about and what they prefer. Unlike other groups this one allowed the seniors to speak for themselves in hope that it would help policy makers and transportation planners better understand the needs of elder. The study provides information on differences in transportation arrangements of different age groups and suggests changes in transportation in relation to their age. (Glasgow, 2002)

A sample size of 10 individuals from 65 to 74 that were relatively healthy and 17 over 75 that reported more health problems than the younger group were surveyed. The findings show that those in the younger group primarily drove themselves, obtain transportation from family, or used a public bus. The older group, interestingly enough, used all of these modes of transportation along with two additional modes as their primary means. The additional modes were rides from friends or neighbors and door-to-door senior citizens transportation. (Glasgow, 2002)

We can see that transportation and effective solutions to transportation are crucial in the older senior group. Those that are healthy enough provide whatever means of transportation

\[
\delta_i = \beta_1(r_i) - \beta_2(EPT_i) + \beta_3(p_i + q_i) + \beta_4(d_i),
\]

Figure 1: Trip Characteristic Equation
they can which may force them to ask neighbors and friends or use door-to-door transportation. This study on serves to reinforce the fact that the development of a door-to-door senior transportation service is important and may become a viable business venture as the population of seniors will more than double by 2030. (Glasgow, 2002)

2.4 Frail Elder Care

In discussion of frail elder care as it relates to patient care, implementation of Information communication technology initiatives and the use of restraints in elder care will be analyzed. The structure of elder care systems need to be explored to provide insight and establish benchmarks for application to the transportation decisions. Four research studies related to elder care were examined. The first study outlines how information communication technology is viewed from the perspective of patients and caregivers. The second discusses how family based patient care is on the decline and how PACE programs provide patients a means to receive formal care in an informal, more community-based way. The third discusses the role of caregivers in patient care and how caregiver competency and the quality of care become influenced by the support systems and resources available. The fourth discusses the use of physical restraints and how nurses view their use.

An interview study of healthcare personnel in Northern Sweden provides a qualitative analysis that outlined the duality of information and communication technology (ICT) in eldercare. This study outlines the implications of ICT and how it promotes humane and inhuman care to patients.

From the perspective of patients receiving care, ICT has many capabilities. Firstly, ICT programs may reduce the intimacy of care as compared to when ICT is not used. Secondly, ICT can help provide quality care as an alternative to conventional practices of personal interactions
to build patient-physician relationships. Thirdly, ICT provides effective solutions for patient care when personal communications are limited by either geographical or physical movement limitations, through the use of automated calling systems and appointment reminders. ICT maintains patient dignity by encouraging communication such as phone checking as opposed to face-to-face meetings with care-givers. ICT can be modified to fit patient needs. ICT can encourage captivity and limits freedom by making patients captive in their home life; however, it encourages freedom through independent living arrangements. (Savenstedt, 2006)

From the perspective of the caregivers of providing care, ICT can create dissociations when used as a primary option for care. This finding is driven by the caregiver’s personal commitment to care, if highly motivated more personal care generally ensues resulting in the use of more face-to-face communication as opposed to ICT. ICT is an effective tool for more frequent communication, and monitoring. ICT can provide a solution to reduce cost by cutting staffing for patient care. Resistance to ICT systems stems from required training, and technological challenges that may arise. (Savenstedt, 2006)

Study results showed that the quality of elder care is directly proportional to the quality of the communication process. ICT can be an effective tool in patient care but should not be the primary means of communication whenever possible. Patient care with regard to ICT should be considered ethically and a solution should be developed to provide the quality patient care whenever possible. (Savenstedt, 2006)

This study is relevant to our analysis because the implementation of ICT as a means to handle participant routing needs to be explored. Participant transportation logs and tracking systems should be explored as a means to increase security and participant privacy with regard to transportation. ICT also presents limitation, as HIPA laws need to be followed to protect
participant privacy. These concerns need to be explored prior to any ICT decisions. Increasing use of ICT supports alternative means of providing care in institutional and community based care systems. (Savenstedt, 2006)

A second investigation relevant to our study found that in-home and long-term community care services have been developed and are an alternative to institution care providing participants more freedom and comfortable environments. Community based care programs like PACE provide participants who need care the opportunity to receive quality care by providing formal medical services in a community environment. Community based care systems work in conjunction with in-home caregiver’s to provide a more personal care program. Without this connection community based programs can be less effective in providing care for program participants. (Tennstedt, 1993)

A cross-sectional interview study examined 240 randomly sampled spousal and frail caregivers in Jerusalem to show the connection between quality of care and burden observed by study participants. Study parameters included caregiver background variables, general self-concept and feelings of caregiver competence, informal and formal social support, burden and levels of health-care facilitation. Path analysis was performed to clarify the direct and indirect predictors of health-care facilitation. (Greenberger, 2003)

Caregiver facilitation of health-care was positively related both to the presence of personal and social resources and to burden. The results suggest that quality care-giving can coexist with burden, provided that ample caregiver resources are present. Caregiver sense of competence and support from the professional health-care provider a major concern outlined in the study. (Greenberger, 2003)
As outlined earlier in the study by Savenstedt (2006), ICT is a useful tool to help care providers and caregivers to provide care for patients. In community-based care programs like PACE, ICT between in-home caregivers and program caregivers is essential to provide high quality care to program participants. In this communication process care provider prescriptions need to be followed to deliver the best care for the patient. A study conducted by Karlsoon (2000), examines caregivers judgment in physical restraint use. Physical restraint use is part of a care provider’s prescription.

Healthcare practices use physical restraints as a means to promote safe practices in healthcare to protect both the participant and the caregiver. Physical restraint use has been shown to have a negative impact on the quality of life of a patient if used extensively. These restraints are defined as any device that limits a participant’s movement or access to their person. Physical restraint use is a decision that is made by the care provider and is to be carried out by the caregiver. In applications such as transportation of frail participants procedures need to be developed for all participants where restraints aren’t necessary or can be used electively. (Karlsoon 2000)

The study evaluated the perception of restraint use in elder care amongst registered nurses in two long-term care settings. A Perceptions of Restraint Use Questionnaire was developed to measure the nurses’ views on restraint use. It was found that nurses fell into two categories those who would continue to use the restraints at the patients request to have the restraint removed and those who remove the restraints if the patient wished to have it removed. (Karlsoon 2000)

Nurses who elected to use the restraints represented 70% of the experimental results. These decisions were based on four criteria lack of time; a duty to obey a prescription; acting in
the best interests of the patient; and acting in accordance with the will of others. The first criterion involved nurses not having enough time or staffing to care for a patient while they are not restrained. When restraints are used the patient can be in an area with limited or no supervision for a period of time. The second criterion to obey the prescription relates to following physicians instructions to use the restraint and to avoid possible consequences of malpractice during patient care. The third criterion to act in the best interest of the patient related to the patient not being able to decide for oneself or loss of judgment due to illness. The fourth criterion involves acting in ordnance with physicians, families, and other care-givers. Nurses that used this argument recognized that their care for a patient needs to reflect the views of all parties involved and as such they need to follow the care plan in regard to restraint use. (Karlsoon 2000)

Nurses who elected to remove the restraint based their decisions by any one or combination of three criteria: harm to the patient; respecting the patient's autonomy; and nurses' willingness to take risks. The nurses believe that the patient could be harmed by using the restraint through struggling to remove the restraint and the psychological impacts restraint use could have on the patient. In regard to respecting the patients’ autonomy, nurses believed that the patient should have the option to elect to not be restrained. In the third argument, nurses belied that at times risks have to be taken to administer care and that preventative practices should be used as a solution once an events occurs. (Karlsoon 2000)

In both cases the nurses expressed conditions for when the decision to use restraints can change, but overall agreed that the decision to use restraints is a difficult one and that a wealth of information need to be considered to make a decision. The decision is a judgment call that the nurse has to make if they are going to remove the restraint and in most situations it is not recommended to remove the restraint; it also shines light that nurses are limited in their ability to
make decisions in where ethical boundaries become skewed. Most nurses elected to use the restraints regardless of patient’s wishes due to the consequences of such an action. (Karlsoon 2000)

2.5 Grants

Due to the capital expense of acquiring vans, an alternative solution for funding was sought. A New England-based PACE program is a nonprofit organization and because of this fact, they are eligible for various federal and state grants. A search for grants through various grant networks and online resources proved to be ineffective. These searches resulted in a myriad of grants that did not pertain to the situation. The solution for this was to simply look at similar programs and determine what their source of funding was. This type of search found Title III, Section 5310, Section 5311, Medicaid, Special human service and transportation programs, local revenues, and private sources as the sources of funding for similar programs. The most relevant of these funding sources are Title III which provides funding for access service such as transportation and Section 5310 which provides funding for vehicles and capital equipment for services of seniors.

Title III defines what services should be provided at the local level in order to provide a comprehensive supportive elder care service. It supports 57 state agencies and over 670 area agencies on aging. The funds are allocated based on the state’s over 60 population as compared to other states. In terms of providing funding for a New England-based PACE program, Title III B is the most relevant one. It provides funding for support services to the elder such as access services, in-home services and community services.

Some relevant compliance requirements for supportive services are provided below. Office of Management and Budget, OMB, Circular A-133 identifies the program in depth.
Service Providers
Supportive Services and Senior Centers and Nutrition Services

a. Funds may be used to assist in the operation of multi-purpose senior centers and to meet all or part of the costs of compensating professional and technical personnel required for center operation (42 USC 3030d (b)(2)).

g. Funds may be used to acquire (in fee simple or by lease for 10 years or more), alter, or renovate existing facilities or to construct new facilities to serve as multi-purpose senior centers for not less than 10 years after acquisition, or 20 years after completion of construction, unless waived by the Assistant Secretary for Aging (42 USC 3030b).

(Department of Health and Human Services, 2004)

The requirements provided in the circular leaves room for interpretation. For example, it does not specify if vans purchased with grant money must be used entirely by the non-profit agency for purpose of transportation of participants only. Questions should be directed to the Agency on Aging because they allocate the funding and control the requirements for use of such funds.

Section 5310 provides funding to nonprofit groups to meet the transportation needs of the elderly and person with disabilities when the transportation service provided is unavailable, insufficient, or inappropriate to meeting their needs. Similar to Title III, funds are allocated to the states based on the state’s elderly population compared to other states.

The eligible recipient for this grant is the states. They apply for funds on behalf of the states’ area Agency on Aging for purposes of capital project. Local agencies, such as, a New England-based PACE program, and those seeking funding must obtain the funds from State Agencies on Aging. Most of the funds are used to purchase vehicles. Details of requirements and use of funds are given in the Federal Transit Authority Circular 9070.1F.
The process of obtaining grants to offset costs is a long and complicated process; however, the benefits of grants may be well worth the effort. Costs that are associated with the initial years of starting up a transportation service may be offset by grants and this might provide a New England-based PACE program with enough justification to begin its own transportation division. By offsetting the costs in the initial years, a New England-based PACE program is given the opportunity to gain experience and improve its efficiency in transportation thereby allowing it to better compete with current transportation vendors.
3. Methodology

The goal of this project was to assist in evaluating the business case for insourcing some or all of a New England-based PACE program’s transportation needs. Systematic analysis of the costs and operational concerns is essential. Providing technical analysis and directed research benefit the customer both for this decision and improving existing practices. Interfacing with the client’s existing infrastructure to gain insight into the present state of the operations and potential room for improvements is important. This enables both more accurate analysis and generates higher levels of buy-in from the customer on the validity of the study.

3.1 Defining the Project Scope

Initially in undertaking any project of this sort it is essential to discuss and manage the scope such that meaningful output can be produced in a relevant timeframe to the customer’s satisfaction. Identifying the overall characteristics of the project as well as stakeholders, key staff, and facilities is important in that it helps frame the problem clearly for the outside team to provide the maximum benefit. These stakeholders include: the Divisional President of Senior Care and Living, Director of Operations, Senior Financial Analyst, and Executive Director.

Trained analysts examining an operational problem with which they are not familiar must take time to learn about both the general nature and particular instance of the issue. Touring both client sites was highly beneficial as it provided insight into the operational constraints from firsthand experience as well as initial opportunities to interface with personnel. Notably, the site directors and transportation coordinators were very helpful by organizing existing data and collecting more on request. The site directors were contacted early on with two goals in mind; to introduce our team to each director and to schedule a time to go on site and observe its operations in an unobtrusive manner. The visits to both sites were scheduled in the afternoon with plans on revisiting the sites in the morning at a later time. However, due to the refocusing of
the project from operations at the site level to overall business decisions, we did not follow up in person after the initial visits.

Extensive work with the client to build the relationships and pathways that will enable the inquiry to efficiently move along productive routes is highly important. Regular meetings with key stakeholders helped ensure that this project remained in line with expectations and facilitates buy-in. These weekly meetings with the Executive Director, the Director of Operations, and towards the final stages of the project a Senior Financial Analysis greatly assisted data acquisition and increased the overall effectiveness of the initiative.

After framing the problem through work with stakeholders and preliminary on-site visits, we conducted preliminary research into the transportation problem faced by PACE programs and similar situations to provide context. Determining the relative scale of the area serviced and total population helped to suggest different potential operational strategies for providing transportation as well as provides cost guidelines.

Following the initial site visits and the general research, we presented our sponsors with preliminary impressions to ensure that they were representative of daily operations. Discussion of the similarities and differences between the client and other PACE programs was helpful in determining what areas to focus on in the analysis. With the project focus shifting from operations at the site level to insourcing, the project team then started gathering data and conducting more directed research.

### 3.2 Data Collection

The next step was to gather essential data to evaluate the cost to provide transportation which falls into two major groups, data used to determine how many vans will be needed and data that helps determine the costs associated with these vans. The first category of data is
primarily composed of the size, frequency, and geographic distribution of the population needing transportation for the next several years. This data was not completely available so was derived based on analysis and extrapolation from existing data. Determining the costs to operate a fleet of chair vans is fairly straightforward and consisted of:

- Capital costs associated with owning or leasing the vans
- Personnel costs for drivers
- Fuel costs
- Other operating expenses such as insurance

This data was gathered from several sources, namely:

- Operational data and estimates from the site directors relayed by the Director of Operations
- Estimates from the Senior Financial Analyst on General Accounting Practices
- Guidelines of business estimates at NEHP from both the Executive Director of and the Senior Financial Analyst
- Research into fuel trending on the US Dept. of Energy’s website (EIA Petroleum Navigator)
- General research to fill in gaps/verify estimates

### 3.3 Model Building and Analysis

The data was used to construct a cost model to facilitate discussion and analysis by enabling various scenarios to be constructed for different possible insourcing levels. The data and modeling also facilitated refinement of the scenarios involved. We used a typical modeling process of model building, validation, and analysis iterating through until a satisfactory output was achieved. This is in line with formal methodology from the National Institute of Standards
and Technology on process modeling: “three basic steps (model selection, model fitting, and model validation) are used iteratively until an appropriate model for the data has been developed” (NIST Website).

3.3.1 Model Building

Initially discussion occurred with the sponsor as to the necessary scope of the model. This included inputs, outputs and the general overall design. Then weekly, new areas were added to the model bringing it closer to a believable forecasting tool and greatly improving the validity of cost projections. The layout and design went through much iteration and inputs were added and removed as well. These included changes in the time frame of the model from yearly to quarterly and to when various costs were accounted for. Test inputs were updated throughout in an effort to ensure the outputs were believable and everything was working correctly.

The final design reflects significant changes, notably the model’s overall robustness was improved from a tool for analysts to a tool for the customer to use in similar analysis by cleaning up working assumptions and documenting the model so that it is easy to revise by personnel without modeling background. It was packaged into a clean “black box” format with all of the inputs clearly marked and ready to be passed in to produce numbers and graphs out the other side.

3.3.2 Validation

In validation frequent iterative revisions occur to the model based on client feedback to ensure that it is believable and useable tool (NIST Website). This step was highly important in this case as the data validity is was at times highly questionable. At other points due to the frequent iterative changes to the overall design, errors crept in such as failing to reduce the number of hours personnel work from yearly to quarterly and thus increasing personnel costs by
a factor of four. Passing actual data in and comparing the outputs to the present state was very helpful at the end of the project to calibrate the model and ensure it is an accurate reference for projecting costs into the future.

3.3.3 Analysis

Analysis was performed on the operational data to evaluate the current effectiveness and potential room for improvements as new sites open. The feasibility of insourcing was examined against a target cost per member per month at a given level of service. Four scenarios were considered: buying vans and using normal full time drivers, buying vans and using a mix of drivers and driver/aides, leasing vans and using normal full time drivers, and leasing vans and using a mix of drivers and driver/aides. Data examined in the course of creating the model highlighted several organizational issues that were not known prior to the study.

3.4 Operational Analysis

The onsite visits to gather data and get a feel for a New England-based PACE program operations were also used to examine the overall problems of timeliness and general routing issues. This operational analysis is presented in more detail in Chapter 4. As a direct result of these visits we came up with Tables 4 and 5 which are examples of suggestions based on site visits that were discussed with the sponsor in order to guide the project. Some were incorporated, such as analysis of other PACE programs’ chair van services and rates, while other such as installing an automatic door at Site 2 were not feasible. Coming back to the client with relevant insight was important as it demonstrated our seriousness and analytic rigor. We were bringing a fresh eye to look at the existing system from the outside, something beyond even the best internal analyst.
Table 4: Brainstormed logistics improvements for Site 1

<table>
<thead>
<tr>
<th>Brainstormed logistics improvements for Site 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organize trips prior to driver arrival.</td>
</tr>
<tr>
<td>Driver notified of routes prior to arriving at site location.</td>
</tr>
<tr>
<td>Get interviews with transportation coordinator, nurses and provider transportation supervisor, site directors.</td>
</tr>
<tr>
<td>Electronics database for participant transportation data may make it easier for driver and transportation coordinator.</td>
</tr>
<tr>
<td>As part of above imbed RFID chips in badges with readers at the door</td>
</tr>
<tr>
<td>Average cost for van service per participant.</td>
</tr>
<tr>
<td>Analysis of chair van services and rates</td>
</tr>
</tbody>
</table>

Table 5: Brainstormed logistics improvements for Site 2

<table>
<thead>
<tr>
<th>Brainstormed logistics improvements for Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Look into why safety belts are used, and how not using them in all cases can reduce load time.</td>
</tr>
<tr>
<td>Transit time to van can be reduced from 5 minutes to 3 minutes if participants are waiting near the entrance.</td>
</tr>
<tr>
<td>Investigate installation of automatic door at to decrease load time and to increase site security.</td>
</tr>
<tr>
<td>Transportation providers should provide drivers and transportation coordinator with estimated drop-off times.</td>
</tr>
<tr>
<td>Cognitively impaired participants may take longer to load on bus than other participants.</td>
</tr>
<tr>
<td>Load last to be dropped off first can reduce time in van by 5 minutes per participant.</td>
</tr>
<tr>
<td>Have transportation coordinator sign out participants instead of driver.</td>
</tr>
<tr>
<td>Better communication between driver and coordinator.</td>
</tr>
<tr>
<td>Drivers may need to arrive earlier to load participants.</td>
</tr>
</tbody>
</table>

Another major component of the operational analysis was an attempt to develop a scoring model as seen in section 5.4.1 to effectively examine the tradeoffs between quantifiable and qualitative aspects of the insourcing decision. Understanding that a New England-based PACE program must trade off time on van directly with cost per member month is important as this is essential to the problem of determining the level of service for the model.
3.5 Capstone Design

Before it can be demonstrated that this project fulfills the requirements for Capstone Design; it is important to understand what design is. As described in the online MQP manual for Industrial Engineering:

“What is design? Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which engineering sciences as well as basic science and mathematics are applied to develop a solution to a problem that meets stated objectives. In IE, the engineering sciences include such areas as optimization, simulation, quality control techniques, financial methods, production planning and control, process analysis and improvement, facility layout, and human factors. Industrial engineering is focused on integrating systems, including such components as people, information, materials and equipment, so design also takes these different components into consideration. Among the fundamental elements of the design process are the establishment of objectives and evaluation criteria, synthesis, analysis, construction, testing, and evaluation. It is essential to consider standards and to include constraints, which in reality limit potential solutions due to economic, safety, reliability and other factors.” (MQP Design)

This project is an excellent example of engineering design. Iterative data gathering, modeling, and discussion occurred to devise a solution to enable a New England-based PACE program to understand the costs associated with potentially insourcing their transportation services. The processes and people, physical equipment used to load/unload and transport the passengers, logistics of routing, were all highly relevant in the project.

An iterative design process occurred throughout the project. The project had two goals the first being focused on improving the logistics and operational aspects of loading the participants and transporting them. The second being, evaluating the cost of insourcing decisions which became the primary focus of the project. Within the insourcing analysis, there were many cycles of data gathering and continually revised expectation definition with the sponsor enabling frequent cycles of feedback to ensure that the project delivered what was wanted. As work
occurred more data was needed, gathered, evaluated, understood and incorporated into the project or discarded as was appropriate with concerns for relevance and feasibility.

A highly responsive sponsor organization that was aware of what it wanted out of the project greatly facilitated the design of this project as timely feedback minimized the amount of wasted effort on non-productive avenues. The sponsor had fairly specific constraints on the project; most notably the analysis has a high level of political/organizational sensitivity as it deals with future policies for external relationships with vendors. Other major examples of design constraints were keeping the overall Per Member per Month (PMPM) cost low, ensuring data quality, and the “believability” of the projections. This design experience was valuable as it contained many constraints and revisions that are not as prevalent in academic design projects.
4. Transportation Services

As previously discussed, a major area of complaint for a New England-based PACE program is transportation. Essentially there are three goals to examine in the context of transportation: the associated costs of transportation, the overall customer satisfaction, and the timeliness of the transportation. The Division President of Senior Care and Living at NEHP expressed a desire to explore the impact of insourcing some or all of the transportation in the on-site project definition meeting with the belief that it might improve control over this service, leading to improved customer satisfaction and potentially reduced costs.

Several third party service providers currently handle transportation services. The New England-based PACE program has experienced several concerns in outsourcing transportation. First, the most apparent problem is lack of control. To provide transportation for a participant, a New England-based PACE program contacts the service provider and provides the participants name, address and time to be picked up. The provider then has full discretion in routing subject to a few guidelines. The guidelines include Elder Care Policies PA-NE-150-001, 002, 004, 005, 006, and 007. These policies and its details may be obtained by contacting a New England-based PACE program; however to briefly describe them respectively, the policies are on Transportation Services, Scheduling Transportation Services, Van Departure Policy, Policy for Safe Pickup and Drop off at Participant’s home, Unsafe Drop Off Situation and Personal Protective Device for transportation. For example, the personal protective device policy outlines when a participants needs such a restraint device and procedures in communicating this with the family members, drivers and facility.

The need for transportation schedules to first be identified then communicated to a third party service provider increases the lead time in service. This affects special trips and trip times.
For example, if a participant finished a scheduled doctor’s appointment early, he must wait for the New England-based PACE program to contact the provider then for the provider to dispatch a vehicle. If the service were to be insourced then it is possible there would already be vehicles on site and thus lead time would be decreased considerably.

The disconnection between the service provider’s employees and a New England-based PACE program’s image and expectation poses a potential problem. The cultures of each company are different and as such employees behave differently. By outsourcing the service, the ability to control the employees’ effect on the customer experience cannot be managed. This may lead to a decrease in customer satisfaction of the service.

There are many potential risks of insourcing transportation that must be gauged to evaluate the potential gain in such a service change. If they were to insource transportation, NEHP would need to take on the full cost of transportation, which consists of costs associated with garaging, maintaining, insuring and operating the vans plus the cost of the drivers. Furthermore, by branding transportation with NEHP, any negative publicity would be shouldered by NEHP alone. For example, if the vans were to break down on the highway, it would be NEHP that would be seen on the evening news instead of a third party service provider.

The goal of this chapter is to examine transportation services. Many of the models presented later in this paper examine cost and how to minimize it. Many business decisions are determined by cost, however other factors are also taken into account. An important factor is how does the change in cost affect the service provided to the customer? Therefore, we examine qualitatively how to improve the value to the customer before delving into models that deal with minimization of cost. At the end of this chapter, the reader should be able to understand the
problems that affect the current system and how each contributes to or detracts from the value and quality of service provided to the customer.

4.1 Site evaluations

In this section, we discuss operations at each site and the observations made during our visits early in the project. We focused on participant loading and unloading, and other issues related to transportation. Figure 2 shows the flow of the transportation process at both sites. It first shows the flow of information when a trip is scheduled and the personnel that handle the information. In addition, it also examines the process taken by a driver to transfer participants from the site to the van. One common issue at both sites that may reduce time is the sign in and sign out process taken by drivers. The drivers must sign in to obtain their routes for the day. Then they retrieve the participants and sign them out. If this process was automated it may reduce waste.

Site 1:

A New England-based PACE program first facility, currently services the most customers in comparison to the two other sites in operation. On average, the site services 112 customers. The site is operating at 100% capacity, which has led to problems that are immediately apparent. PACE regulations dictate that the facilities have 50 ft² for every one person; however, there seems to be no regulation on the space needed outside the facility. More specifically, the parking area at this site is inadequate. Therefore, the site’s main problems stem from lack of space outside of the facility, an outdated participant tracking method, and use of a manual system to verify participants and trip.
The observations from our initial visits to the New England-based PACE program first site in presented in Figure 3. Each observation is broken down in categories and then categorized further into a subjective or objective observation. The categories used to classify the observations are general areas of the service that we observed; for instance, site observations are all observations that pertained to just the site and its operation.
In addition to the observations presented in Figure 3 for the first facility, we noted two problems while at the site. The first problem resulted because a participant was placed on the van but was not supposed to be. This caused the van to be called back after it had been on the road for 15 minutes resulting in delays for that particular person and the other participants on the van. The second problem arose when a participant finished his appointment earlier than expected. His van was scheduled to arrive at 4; however, he was finished at 3.

**Site 2:**

A New England-based PACE program’s second facility, has the same general layout of services as its first facility, in terms of required rooms, but differs in size and membership. The site has ample parking and vans have a dedicated driveway close to the door; however, the door must be manually opened and closed, which poses several major problems and increases loading time slightly. Additionally, the atmosphere at the second site is much different. The site services 36 customers, which is 100% of its capacity. Due to the significant difference in the number of customers at this facility and the customers at the first site, a marked environment
difference can be seen. The staff is much busier at the first site, which increases the risk of mistakes. A few identified problems at the second site are lack of communication between transportation vendor driver’s and the vendor itself in routing, vans are filled to capacity increasing wait time for participants, participants live further apart from other participants, and there is no automatic mechanism to open or lock the front door.

Similar to the charts shown for the first facility, Figure 4 shows the observations from the initial visit to the second facility. The main reason for long ride time is participant location relative to each other and the site. A van may have participants that live 30 minutes north of the site and also 30 minutes south. The time it takes the van to travel north is added to the last participants time and increases it dramatically.

<table>
<thead>
<tr>
<th>Subjective</th>
<th>Observation</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complains about routes</td>
<td>Would like route time to be 60 minutes max</td>
<td>100 enrolled; 36 attendee per day</td>
</tr>
<tr>
<td>Changes route for convenience</td>
<td>Courtesy call to family if route is late</td>
<td>Health Aids wait in vans with patients of need.</td>
</tr>
<tr>
<td>Problems due to driver unfamiliarity with routes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver Duties</td>
<td>Site Observation</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram](image_url)

**Figure 4: Site 2 Evaluations**
4.2 Analysis of Time Consideration

The two main areas identified with transportation complaints are timeliness of pick-ups and drop-offs and length of time spent in the van. The task of loading frail elders into the transportation van can cause delays in several ways. First, the individuals are not always ready and at the door when the vehicle arrives. This necessitates that the driver assist in preparing the elder and loading them into the van. Second, it may be a relatively quick task for those that are younger and more mobile to leave the house and enter a car, it takes at least 5 minutes to load or unload a frail elder. The lack of consistency amongst load time due to the uniqueness of the customer presents several problems to be addressed. Interestingly, the complaints of timeliness are usually lodged by the care-takers, be it children of the elder, relatives or others.

The complaints of the actual customers focus on wait time in the van. Sample routing data indicates that these complaints are valid. Member time in van ranges with the number of participants per route. As the number of participants in a given route increases the time in van also increases. Optimization of routes may reduce transit time; however, several studies have suggested that actual wait time may not directly correlate with customer satisfaction.

An initial solution to improve customer satisfaction involves perception management, specifically: (Whiting and Donthu, 2006)

- Wait time can have an impact on the customer’s perception of service and the customer’s satisfaction with the service encounter.
- Discrepancy between actual and perceived wait time can be very large.
- Actual wait time does not directly affect customer satisfaction.
- Perceived wait time impacts customer satisfaction.
- Music decreases perception of wait and increases customer satisfaction.
In addition to improving routes, simply informing the care-takers of lateness may result in improved satisfaction. Informing customers of problems may increase loyalty and general level of satisfaction with the service. (Siebel, 2005)

In Figure 5, the process of transportation is modeled in a fishbone diagram to explore the concerns with timeliness. Although there are many issues that affect loading and drop off time that may cause lateness, the most substantial issues are relating to routing. This is because a poorly planned route may result in a participant being in the van for up to two hours.

**Figure 5: Fishbone of Timeliness at Facilities**

To explore wait time further, we developed process models to illustrate various aspects of wait time. The model in Figure 6 shows number of participants for each of the three New England-based PACE program sites and the number of vans used to transport participants. The first input node depicts the average number of participants per van based on routine trip averages. The pickup process node shows an estimated load time and van utilization percentage for one participant. Each van starts with one participant and then loads the van until the van has picked up the all participants on the route. The in van transit process node shows the total travel
time for one participant on the van and the van utilization during this process. The Total time is calculated by taking the lead time per participant and multiplying that number by the number of participants on the route. The drop off process node shows the unload time and the van utilization after the van has been unloaded. Once the van is empty the route ends.

Figure 6: Transportation model for routine trips current transportation.

The model in Figure 7 shows participant waits time for routine trips to each of the three New England-based PACE program sites. The pickup wait time process is directly related to how many participants are to be loaded on the van. This wait time ends once the participant has been pickup from a location. During transit process wait time is a function of how many trips the van needs to make until the route is completed. The drop off wait time depicts how long participant may have to wait to be unloaded at a location. This wait time ends once the participant has been dropped off at a location. Once drop off occurs the participant wait time process ends.
Figure 7: Transportation model for participant routine trips Wait-Time during site transport.

The model in Figure 8 shows the number of special trip participants for each of the three New England-based PACE program sites and the number of vans used to transport participants. Special trips require that the participant ride the van alone for the entire route. The pickup process node shows an estimated load time and van utilization percentage for one participant. The in van transit process node shows the total travel time for one participant on the van and the van utilization during this process. The Total time for special trips is estimated based on participant location relative to site. The drop off process node shows the unload time and the van utilization after the van has been unloaded. Once the van is empty the route ends.
Consideration of information flow, timeliness structure and trip time are effective ways to evaluate the current process in regard to transportation and timelines. In regard to timeliness, most of the issues that arise stem from delayed services or lack of communication between parties involved. Figure 5 outlines four areas of concern that affect timeliness and provides the smaller services that compose these areas. This structure provides a guide for improving timeliness overall. Figures 6-9 outline the schedule of trip time for each site and identify the time structure for van transportation. These figures identify the areas of the participant trip on van that contribute to total trip time for a route. Analysis of trip time in van is a significant concern to the sponsor and these figures provide help to address the time consideration of the transportation process.

Figure 8: Transportation model for special trips.
There are many steps in the process of transporting a participant from site to their home. Many of these steps add time that does not really add value. For example, loading the participants in a Last-Out-First-In manner adds a substantial amount of time to the first person loaded. They are the last to leave the van so they will have the longest ride. By loading them first, their ride time increases because they must wait for the loading and unloading process to finish before they can leave. A First-In-First-Out system would reduce the time in van for all participants by spreading the load time evenly.

The highly regulated nature of a PACE program may have added waste to the system. For example, the process of driver retrieving the participants one by one to load onto the van while using a safety harness for all is a very timely process. A solution to this is to utilize available staff and drivers to load one van at a time.

Our examination of the current system only took place during the beginning of our project. Therefore, there is a lot of room for further studies into improving the process. Some considerations for future studies include: examining power structure and resistance to change...
from staff of vendors and the PACE staff, key decision makers in the process, and making the system lean.

### 4.3 Policies and Procedures

A set of policies and procedures were developed to aid in the operations of a hybrid or total transportation system and are presented in appendix 1. These policies were developed as a means to answer operational concerns that follow from site observations, discussion with directors and staff, and research on other PACE programs. (National PACE) Timeliness being a paramount concern when transporting frail participants, Figure 5, shows that three of the four timeliness factors directly involve driver relations; as such driver specific policies were developed to address driver issues. The policies were divided into personnel and operational policies all relating to drivers. The areas outlined in personnel policies cover driver hiring, training, transitioning, scheduling, and absenteeism. The areas specific to operations outline driver’s daily responsibilities, safe driving procedure, and van maintenance.

As mentioned in site Section 4.1, specifically in Figure 4, drivers often were unfamiliar with routes, complained about routes, and even discussed changing routes. As with any process the individuals providing service have a better sense of the process bottlenecks than the individuals scheduling service. Government regulation in regard to frail transportation provides a structure for transportation policies and outline general procedures and responsibilities of the transportation provider. Individual PACE sites add or modify these general regulations to fit a specific need. These polices outlined for drivers are to be used in conjunction with site-specific regulations to provide service for program participants. Although an attempt has been made to be as thorough as possible in the development of these procedures, it should not be taken as an end all solution but only a blueprint for a more focused set of policies.
5. Transportation Model for a New England PACE Program

Faced with projected increases in transportation costs, the feasibility of insourcing some or all of the transportation needs of a New England-based Program of All-inclusive Care for the Elderly is an important area for consideration in providing quality care to customers. Transportation does not directly contribute to customer value, however, transportation adds to the cost of providing care, as such managing transportation cost is essential to managing total cost for providing care. This chapter presents the model developed to analyze the transportation decision and to evaluate the cost involved. A sensitivity analysis is also presented that links cost to other operational considerations, and identifies key cost drivers.

5.1 Scenario Discussion

Three major scenarios are currently examined; more can be created fairly easily and there are variations within each. A full insourcing scenario is modeled where a New England-based PACE program assumes all costs and full control of the transportation of their clients. Then there are two variations of partial insourcing depending on the level of insourcing, represented by whether regular trips are handled or only special trips. The focus of the model is on regular trips as special trip data is variable and represents only a negotiable amount of the transportation service. Currently these two hybrid scenarios are incomplete in that they do not account for the transportation that must be handled by an external vendor as transportation agreements are being renewed. The current state with transportation completely outsourced can be easily modeled, but will not be accounted for in the transportation model.
5.2 Model Discussion

A major output of this study was developing a means of objectively evaluating a broad variety of possible insourcing solutions and their costs. An excel spreadsheet model was developed with input from the sponsor for user requirements, data gathering and conducting additional research into cost structures. Major criteria for this model were ease of use and the ability to adjust components of the model to reflect varying assumptions. The model allows for data updates once more accurate estimates are developed.

The model may appear simple or even trivial upon initial consideration; however in a project as opposed to a classroom exercise the availability, reliability, and even what data is relevant are unclear and required iterative meetings with the sponsors to work out a believable, valid, useful model.

5.2.1 Model Assumptions

Essentially assumptions are used to form the backbone of the model where relationships are simplified either for ease of simulation or due to lack of data. The Baseline Assumptions worksheet in the model contains these assumptions, and is show in Figures 10-12. Working downward each area will be discussed.

- Personnel: Benefits are assumed to be 25% of the base salary for all staff based on client input.
- Personnel: Driver/Aide is conceptually someone who is cross-trained and thus is able to drive people as needed and fill the role of an aide at other times. During the morning and afternoon they will function as a driver and during busy times at the center (midday) they are employed as a regular aide. This increased worker
utilization significantly. The cross-trained personnel are paid an additional rate for all hours worked as a result of their increased training.

- Equipment: Costs are spread across the entire lifetime of the asset evenly.

- Fuel Price: For the purposes of this model fuel prices are assumed to be constantly increasing in all scenarios. Seasonal variability and other factors typically used in more in-depth modeling are not applied for simplicity sake, as this is not the focus of the model. On the baseline assumption sheet a fuel-costing scenario is selected and applied throughout the model.

- Maintenance: This is applied to all scenarios, a fraction of the total cost of the vehicle to maintain it each quarter. While not particularly realistic, this assumption avoids the needing to track the age/mileage of vans and simplifies the model greatly. Maintenance cost parameters are the same for both lease and buy scenarios, future data may suggest that maintenance under leasing is higher than maintenance under buying as once brought van maintenance is elective at the digression of the owner.

- Storage Fees: Initially it was assumed that the cost would be incurred over 4 months, the latter half of Q4 and the first half of Q1. The cost was spread over a year for budgeting purposes.

- Misc. Fuel Consumption: The fuel consumption number was generated by taking average mileage data per participant for each site. This number was multiplied by the number of participants per van and daily route fuel consumption was generated. This generated number was multiplied by 25% to account for idle fuel consumption.
- Ave # Participants Round Trips Per Day: is derived via dimensional analysis from the site census using the Ave # of Round Trips per week per participant and the census at the given site. There is a percentage factor for ridership that takes the total number of participants to be transported based on census data and multiplies it by a percentage to get a more accurate account of the actually transportation ridership per site.

- Ave # Participants per van: This number feeds into the other sheets as it determines how many vans are needed at each site based on the target ridership. It assumes that each van is only used to serve one route as data was lacking and or inadequate on the logistics involved in enabling a van to run multiple routes.

5.2.2 Model Description

The model was developed using Microsoft Excel ® software. Figures 10-15 represent images of the model structure used for analysis. The legend represented in Figure 12 is used for Figures 10-12; it depicts how one should read the cells colors and text colors presented in the assumptions sheet. The calculations used for this model are presented in Table 6. The calculations are used to produce model outputs and the corresponding calculation names appear in Figures 13-15.

**Inputs and Calculations**

Figure 10 shows the table for personnel costs outlining the base pay for each of the positions, inputs include base pay and cost of living increase. The model calculates a six-year spread of the cost of wage cost for each position adding a cost of living increase. The equipment costs are also represented, including the purchase cost and leasing schedule for the vans. These equipment values are all inputs of the model.
Figure 10: Personal and Equipment Costs

Figure 11 shows the fuel price initial value and inputs for quarterly increases according to low and high increase. The yearly fuel price is then calculated over four fuel scenarios. The miscellaneous cost table includes insurance per quarter scheduling software and detail fuel data used for calculating yearly fuel numbers. Maintenance cost and storage fees are also listed here. Fuel scenario selection is made here according to which model is to be used for evaluation.

Figure 11: Fuel Schedule and Additional Expenses

Figure 12 shows the entry field for the membership census data, listed by site per quarter. The average number of trips per week is presented as well as the ridership and participants per
van input cells are presented. Participant trips per day are listed per site per quarter calculated par the census numbers. The route data presented for each site and the legend for the series of tables presented. The results of these inputs can be seen in Figures 13-15.

<table>
<thead>
<tr>
<th>Number of Participants per site</th>
<th>Year1Q1</th>
<th>Year1Q2</th>
<th>Year1Q3</th>
<th>Year1Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Site 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ave # of Trips per week per Participant</th>
<th>Ave # Participants per van</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1 % Ridership</td>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2 % Ridership</td>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3 % Ridership</td>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4 % Ridership</td>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5 % Ridership</td>
<td>Site 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ave # of Trips Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ave # of Special Trips per week per Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Route Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Time Per participant per trip</td>
</tr>
<tr>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5</td>
</tr>
</tbody>
</table>

Legend:
- Yellow filled box denotes user input field
- Unshaded boxes contain formulas
- Red text represents estimated values

Figure 12: Member Transportation and Route Data

**Model Output**

Figure 13 shows the personnel cost calculation fields as well as the van costs calculation fields for van lease and purchase, including maintenance costs. The calculated costs for personnel are presented by site and per quarter resulting in a total personnel cost per scenario and quarter. The van cost for purchase and lease are tallied including maintenance expenses presented per quarter. These outputs are the result of the inputs in Figure 10.
Figure 13: Personnel and Van Costs

Figure 14 shows the fuel cost per quarter, miscellaneous costs, and number of vans to be purchased. The fuel cost per quarter was derived from the fuel price and fuel consumption calculations, also presented is the scenario chosen for fuel price calculation inputs. The miscellaneous cost is composed of the calculated storage fees, insurance and software costs as presented in Table 6. The number of vans per site is calculated by combining the average participant trips and participants per van calculations. The calculated costs for fuel are presented by fuel scenario and per quarter. The total miscellaneous costs add the storage, insurance, and software cost presented per quarter. The total fleet size is calculated by adding the number of vans needed at each site presented per quarter. The number of vans needed calculation is presented in Table 6. The outputs presented here are the result of the inputs in Figures 11 and 12.
Figure 14: Fuel Cost, Additional Expenses and Van Purchases

Figure 15 shows the total for all costs in the model presented per quarter based by insourcing percentage. The 100% cost shows the all cost involved based on model calculations for leasing using drivers or driver/aide mix, and buying using drivers or driver aide mix. The 75% and 50% insourcing scenerios are based on the 100% insourcing costs, scaled down by 25 and 50 percent respectively. The outputs of this figure incorporate all model calculations presented in Table 6 and are the basis for model analysis.
### Table 6: Model Calculations

<table>
<thead>
<tr>
<th>Calculations Title</th>
<th>Formula</th>
<th>Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Costs: Drivers</td>
<td>Number of vans at the site* (1+Personnel Buffer for Van Drivers)<em>Pay rate for that year</em>8hrs per day<em>5 days per week</em>13 weeks per quarter</td>
<td>Personnel Buffer (what % excess personnel are needed for smooth operations), Pay rate for year (either drivers or driver aides),</td>
</tr>
<tr>
<td>Personnel Costs: Driver/Aide Mix</td>
<td>%Driver<em>cost from 100% drivers+ (1+Personnel Buffer for Van Drivers)</em> %driver/aides<em>number of vans at that site</em>Pay rate for that year*# Hours day Driver/Aides bill to transportation <em>5 days per week</em>13 weeks per quarter</td>
<td>Personnel Buffer (what % excess personnel are needed for smooth operations), Pay rate for year (either drivers or driver aides), %driver vs. driver/aides, number of hours Driver/Aides bill to transportation</td>
</tr>
<tr>
<td>Van Cost</td>
<td>(Fleet size*purchase price of van)/ 4 quarters per year/ 5 years</td>
<td>Assumes a 5 year useful life and the purchase cost is spread out evenly over the entire period</td>
</tr>
<tr>
<td>Van Lease Down payments</td>
<td>Total Purchases for that year (with 1st yr spread over 5yr)*lease down payment</td>
<td>All vans purchased in the first year are spread evenly across the entire period for costing</td>
</tr>
<tr>
<td>Van Lease Monthly Payments</td>
<td>Fleet size<em>monthly payment</em>3 months per quarter</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>Total fleet size*cost of insurance</td>
<td></td>
</tr>
<tr>
<td>Scheduling Software</td>
<td>Cost of software/4 quarters per year/5 years</td>
<td></td>
</tr>
<tr>
<td>Fuel Cost</td>
<td>Current fuel cost in that scenario* gallons per van per day<em>65 days per quarter</em>total fleet size</td>
<td>Current fuel cost for that time period and chosen scenario, gallons per van per day, total fleet size at the current time</td>
</tr>
<tr>
<td>Maintenance Expenses</td>
<td>Fleet size* Maintenance % per van per quarter*total cost of the van</td>
<td>Maintenance expenses are spread evenly across vans life and is a % of its purchase cost</td>
</tr>
<tr>
<td>Storage 4 months a year spread out</td>
<td>Total fleet size*cost per month</td>
<td>Actually stored November to February but expensed as one month per quarter</td>
</tr>
<tr>
<td>Fuel Costs per quarter</td>
<td>Average Fuel Consumption per day per van <em>total fleet size</em>cost for fuel in that time period in that scenario *65 days per quarter</td>
<td></td>
</tr>
<tr>
<td>Number of 6 Passenger Vans needed</td>
<td>Ave # Participants Round Trips Per Day at that site in that time period/ Ave # Participants per van at that site+ Special Trips Per Day Round Trip/2.</td>
<td>Vans are only used on one route, special trips can occur at non peak times and require half as many vans to support</td>
</tr>
<tr>
<td>Ave # Participants Round Trips Per Day</td>
<td># of Participants at point in time at that site* Ave # of Round Trips per week per Participant/5 days per week *% ridership</td>
<td></td>
</tr>
</tbody>
</table>
5.3 Cost Model Analysis

The model behaves robustly as long as care is taken to avoid structural changes. The goal was to develop a “black box”, which inputs are passed into and data is produced representing the costs for various insourcing scenarios. The four scenarios examined in the test run reported here are: leasing the vans and hiring full time drivers, leasing the vans and hiring fewer drivers but cross training some aides to work as drivers during the morning and afternoon and then switching to an aide during peak aid times around noon, buying vans and hiring full time drivers, and finally buying the vans and using a mix of full time drivers and driver aids. The percentage mixture of the driver aides can be varied within the model, but here is assumed to be 20%. For this sample run of the model all four scenarios exceeded the targeted cost of outsourcing and thus the decision would be to outsource 100% of transportation if cost were the only driver. However, this tool is used to quantify cost as a springboard for discussion while considering the qualitative aspects of transportation that are not necessarily addressed by the model.

As part of facilitating this discussion, it is highly useful to examine costs over time and the components of the costs as seen in Figures 16-18. The sponsor organization will use this data on various runs of the model to evaluate the reasonableness of transportation contracts and for other strategic decisions. The graphs are automatically generated as changes are made to the model inputs, an important component of an effective “black box” solution.

Figure 16 shows the quarterly cost $ Per Member Per Month (SPMPM) for transportation and related expenses across all 4 scenarios for this run of the model. These numbers are generated from the total costs worksheet in Figure 15 by dividing by the member population estimated for that quarter for each quarter over 5 years.
<table>
<thead>
<tr>
<th>Cost</th>
<th>Time</th>
<th>Lease Drivers</th>
<th>Lease Driver Aid Mix</th>
<th>Buy Drivers</th>
<th>Buy Driver Aid Mix</th>
</tr>
</thead>
</table>

Figure 16: $PMPM over 5 years across all 4 scenarios

Figure 17 is highly relevant as it showcases the components of the $PMPM over the 5 year period for one scenario in depth. Currently the capital cost is spread across the entire time period fairly evenly, staffing and misc costs seem to increase slightly over time, fuel costs increase dramatically PMPM over time. The assumptions used for fuel calculations in the model are subject to user input where the user picks a fleet volume and a consumer volume for initial pump prices in 2008Q1 and inputs two rates for quarterly increase in fuel pricing. The scenario used for this example assumed an initial consumer price at the pump of $3.00/gal and a 7% per quarter increase in the price of fuel over the 5 year period. This yields a 2012 Q4 price of $10.85 per gallon and represents the most pessimistic fuel expectations barring a collapse in petrochemicals. Essentially this high increase in fuel prices can be attributed to the rate of
increase in the global demand for fuel outpacing the rate of increase in the global supply of fuel, causing significant price increases if not systematic collapse. The underlying assumptions of this high increase can be examined in detail in “US ENERGY GOALS AND POLICY: A Critical Look at Existing Energy and Sustainable Energy for the Future” (Chan et al., 2007).

![Area Chart of $PMPM breakdown over 5 years for Buy Driver Aid Mix](image)

**Figure 17:** Area Chart of $PMPM breakdown over 5 years for Buy Driver Aid Mix

Figure 18 compares the components of the $PMPM for each scenario in 2008 and 2012. This figure is helpful as it shows that across all scenarios fuel increases significantly and staffing costs increase moderately. More generally, for any inputs it permits comparisons across scenarios and over time.
5.4 Secondary Analysis

Several analysis were undertaken to further explore the model and its robustness. The first analysis is a scoring model that serves to validate that customer service is an important issue. The second analysis of trip time serves to relate cost increases associated with an increase in service level. The last analysis seeks to determine how changes in model affect results.

5.4.1 Scoring Model

Although the Excel model projects the cost of various scenarios for insourcing, a cost based analysis is not sufficient by itself. It merely dictates if insourcing is feasible for a New England-based PACE program financially. While the feasibility of the task is a major determining factor, there are several other factors that affect the decision. Cost, timeliness of pickups and drop-offs, customer satisfaction, control over the transportation service and
expertise in the service are all major criteria to consider. In addition to this, the effect of parameters in the model on these criteria would help clarify major drivers in the model that are associated with the criteria. To more accurately determine what criteria were important to NE PACE, several surveys were sent out to the two site directors and the director of operations in order to create a scoring model. These survey participants were selected because they had the most knowledge about the transportation problems and deal with transportation issues on a regular basis. These models are helpful in evaluating third party logistic providers to determine which provider most closely aligns with the company’s criteria. (So et al., 2006)

The surveys served to first define what criteria were measured or needed to be measured and then asked to rank these in order of their importance. This task was accomplished listing key areas that a transportation service provider would be evaluated on when deciding whether to go with that vendor or another. The list of approximately 20 items was sent to these individuals. Then they were asked to either suggest 5 items that they would use to evaluate a vendor or to choose from the list provided. The resulting list of items was then compiled and a second survey was sent to all of the individuals. They were asked to rank the criteria from 1 to 5 based on importance with 5 being the highest.

The Transportation Provider Scoring Model in Table 7 is the result of the survey sent to site directors at Site 1 and Site 2, and the executive officers at a New England-based Program of All-inclusive Care for the Elderly. The participants were asked to rank the criteria (cost, timeliness, customer satisfaction, expertise, and control) in order of importance. The item that was ranked highest was given a score of 5 and lowest a score of 1. The average of each criterion was taken and then used as the weight for another scoring model. According to the survey,
timeliness and expertise are the most important factors in choosing a transportation provider. Cost on the other hand was less important to the survey participants.

Table 7: Transportation Provider Scoring Model

<table>
<thead>
<tr>
<th>Criteria</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Timeliness</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3.33</td>
</tr>
<tr>
<td>Expertise</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3.67</td>
</tr>
<tr>
<td>Control</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

The Scenario Scoring Model shown in Table 8 was a result of the previous exhibit. By using the weight of each criterion, different scenarios were evaluated. Option A corresponds to choosing a major transportation provider with an established infrastructure. Option B corresponds to smaller transportation vendors that have a small fleet. Option C corresponds to insourcing the service. A score was determined by multiplying weight by the rating. Each scenario was rated by the project team on a three point scale with three assigned to the option that we perceived was best for that criterion, depending on how each compared to the current service providers.

The scoring model analysis shows that customer service is paramount as opposed to cost. This is not surprising as the participants surveyed had goals of providing quality service. Their focus was to improve the service to the customer, and they did not emphasis cost as was reflective of the survey. This model serves to illustrate the point that a balance between cost and service should be achieved.
5.4.2 Ideal Transit Time Model

To illustrate the additional cost or need of additional equipment/trips to increase service level, a model was created in Microsoft Excel. This model allows the users to input fuel costs and average mileage data. The outputs are several intermediate calculations with the final product being the percentage of additional vans needed to meet desired time in van and the cost of service per van. This model presents a link between the cost model, the scoring model and the sensitivity analysis. It shows that to achieve a greater service level, there must be increases in number of routes, vans, or cost.

Table 9 shows three parameters that may be modified---average trip mileage from that site, estimated fuel cost, and driver wages. The average trip mileage from the site is determined by taking the sum of the distance of all members from one site and dividing that by the total number of members. Although with a large enough number, the value may be close to actual there are a few limitations that must be noted with using this model. Because averages are used, it may not take into account the outliers on a trip. This becomes even more significant with an increase in the number of total members. In addition, it assumes that each route is the average
mileage from the last point. For example, the trip from site to the first house would be x amount of miles. The next trip from the first house to the second house will be x amount of miles also. This models the route imperfectly. Routing software with trip information from all participants would make this model more robust and accurate. However, with the absence of routing software, trip time may not be accurately modeled for each participant. It does take into account the time and mileage of the system and serves as a foundation for exploring how the system changes.

Several calculations are made from these inputs and assumptions that go along with it. First, it is assumed that average load and unload time per person is 5 minutes. This factor is multiplied by the number of participants on a van and then doubled to obtain load and unload time.

Table 9: Ideal trip time parameters

<table>
<thead>
<tr>
<th>Sites</th>
<th>Average Mileage</th>
<th># of Participants</th>
<th>Estimated Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.36</td>
<td>3.186721992</td>
<td>$3.00</td>
</tr>
<tr>
<td>2</td>
<td>9.01</td>
<td>2.8828125</td>
<td>$3.00</td>
</tr>
<tr>
<td>3</td>
<td>7.56</td>
<td>3.617006568</td>
<td>$3.00</td>
</tr>
<tr>
<td>4</td>
<td>8.36</td>
<td>3.186721992</td>
<td>$3.00</td>
</tr>
<tr>
<td>5</td>
<td>9.01</td>
<td>2.8828125</td>
<td>$3.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sites</th>
<th>Load Time</th>
<th>Route Mileage</th>
<th>Route Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.93360996</td>
<td>43.36099585</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>14.4140625</td>
<td>43.99414063</td>
<td>120</td>
</tr>
<tr>
<td>3</td>
<td>18.08503284</td>
<td>42.46456965</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>15.93360996</td>
<td>43.36099585</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>14.4140625</td>
<td>43.99414063</td>
<td>120</td>
</tr>
</tbody>
</table>

The next calculation is the total time in van. This assumes that the van drives at an average speed of 25 miles an hour. The time is obtained by multiplying the average mileage by the number of riders and then adding 2 times the average mileage to account for distance to first
pick up and distance back to station after last drop-off. This gives the total mileage; to convert this to time, we multiply by (25mph) / (60 minutes / hour) to obtain time in minutes.

After these calculations of load time and route mileage is calculated, the final area that can be changed is route time, which can be seen in Table 10. This is the ideal time that one wants the passengers to be on the van for. By using goal seek and inputting this time, the model outputs the number of additional vans needed and the cost of service.

In Figure 18, we can see the model results. However, the model only shows the additional percentage of vans needed to meet the desired service level. It assumes that all vans are 6 passengers vans and does not account for any hybrid solution. For example, a model in which 6 passenger vans owned by NE PACE and a fleet of contracted taxis are combined to maximize service while minimizing cost cannot be modeled in the ideal trip time. The model only serves to illustrate the additional number of vans needed to obtain service level when using a 6 passenger van and how much it costs for driver and fuel per trip. This cost is determined by multiplying the total time for a van by driver wage and then multiplying fuel price with the total number of fuel consumed on the trip.

<table>
<thead>
<tr>
<th>Service Cost Per Trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of Additional Vans Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
</tr>
<tr>
<td>Site 2</td>
</tr>
<tr>
<td>Site 3</td>
</tr>
<tr>
<td>Site 4</td>
</tr>
<tr>
<td>Site 5</td>
</tr>
</tbody>
</table>
5.4.3 Sensitivity Analysis

Sensitivity analysis is commonly used to illustrate the changes that occur in a model due to the changes in the value of the parameters. (Choudhari, 2001) The analysis looks at the uncertainties in the model and helps to build confidence in the estimation. As many parameters are real world values, it is very difficult to measure each with a great deal of accuracy. In addition to this, the values are constantly changing. Fuel prices, wages, van costs, and many other factors will fluctuate over time. Therefore, because of the estimate, a sensitivity analysis is carried out using the SensIt® add-on in Microsoft Excel® to show what level of accuracy is needed for a parameter to make it useful enough or valid.

The sensitivity analysis shows how the model behaves in extreme situations. By finding out how the parameters interact in extreme cases, we can identify which parameters are the major cost drivers. This serves the purpose of both identifying the most crucial parameters that will affect the decision and illustrates how the parameters may react.

In our case an analysis was done with a base case and two extreme cases. The parameters were modeled around the 2008 Q1 figures and then a 50% increase and decrease was applied to base costs to obtain the extreme cases. To illustrate the amount of swing of each parameter, a tornado and spider chart were created and shown in Figure 19 and 20. Figure 19 shows that the $PMPM cost is very sensitive to change in personnel costs with fuel costs being second. Figure 20 shows the same results but presented in a different way.
The Personnel Costs parameter is affected by two variables—the wages paid to drivers and the number of total drivers. This can vary significantly with the population as an increase in drivers must go hand in hand with an increase in population to adequately meet the
transportation needs. In addition, over time, the cost of driver wages will increase as cost of living and minimum standards are increased.

According to the sensitivity analysis above, there is an 88.2% range in personnel cost across the scenarios considered, which indicates that this is currently the largest cost driver by far. The sensitivity analysis only modeled a 50% change in the base case, as seen in Table 11; however, this parameter affected the end result of $PMPM price by a significant amount. Methodology for the hiring, training and compensation of personnel is a crucial area to explore. These areas should be well planned and highly regulated to reduce the amount of variation possible in personnel cost.

| Table 11: Sensitivity Analysis for Projected 2008 Q1 Estimates |
|---------------------------------|-----------------|
| Input Variable                  | Swing^2         |
| Personnel Cost Driver Aid Mix   | 88.2%           |
| Fuel Costs                      |                 |
| Per Q                           | 6.1%            |
| Misc                            | 3.4%            |
| Lease Costs                     | 2.3%            |

Fuel Cost showed the second greatest amount of impact on the model. In fact, it represents more than two other costs, lease/purchase cost and misc cost, combined. Although, the 50% change resulted in a far less significant swing than the Personnel Costs, one must take into consideration that the current price of fuel is modeled at $3/gallon. Therefore, any changes modeled for that case will not be significant as compared to personnel cost. Due to the nature of fuel prices and the likelihood of increase in the near future, this parameter must be closely examined. It’s volatility to change is already illustrated in the analysis; however, the amount of volatility is greater if the model is projected further into the future. The current swing is
significant when the fuel price is only $3. If the price increases according to the projection the swing might be 3 to 4 times greater.

Personnel Costs and Fuel Cost are illustrated as the major drivers in our model. This is logical as they are the variable costs. The other costs, misc costs and lease/purchase cost can be recognized on the books as fixed costs and allocated to each quarter in equal amounts over x period of time. The analysis shows the volatility of personnel costs and fuel costs, which suggests closely watching these parameters.
6. Conclusions and Recommendations

The goal of this project was to evaluate transportation at New England-based PACE. There were three major areas examined: the associated costs of transportation, the overall customer satisfaction, and the timeliness of the transportation. The Division President of Senior Care and Living at NEHP expressed a desire to explore the impact of insourcing some or all of the transportation in the on-site project definition meeting with the belief that it might improve control over this service, leading to improved customer satisfaction and potentially reduced costs. This work resulted in the creation of policies and procedures, models for evaluating the insourcing decision, and analysis of project per member per month costs ($PMPM) across several scenarios including a sensitivity analysis.

6.1 Conclusions

The project was an excellent learning experience for the students involved and highly beneficial for the sponsor organization. Exposure to corporate sensitivity to data, difficulty in gathering valid data, and responding to iterative feedback cycles are real world experiences that are impossible to replicate effectively in the classroom. In addition, a New England-based PACE gained significant insight into their transportation program from an outside perspective and gained a new tool for future business decisions.

6.2 Model Conclusions

The cost model developed to evaluate insourcing options meets the design requirements for ease of use and effectiveness. Structurally it is a solid tool for supporting the decision making process. Functionally, the accuracy is reasonable and responsive to changes in inputs. Adjusting input parameters to better estimate future costs is a major benefit of the modeling component of the project. The sponsor has an excellent grasp of the mechanics involved in modeling and
frequently contributed to reality checks on the inputs. Further work and refinement is feasible and likely. Considerations to take into account for the future are that the model is most sensitive to cost of personnel, fuel and census data. Changes in these variables will have the most drastic affect on the model and therefore any efforts to reduce cost should take this into account.

Based on the final model, it does not appear to be cost effective to insource any of the transportation services if a vendor is able to provide them at the desired price $PMPM. As a New England-based PACE moves forward with negotiations with vendors it will be interesting to see if they are able to realize vendor prices at this target level.

6.3 Recommendations
Revising data on the logistics and improving the operational efficiency of routing has potential to reduce the number of vans needed to service the member population significantly, while still retaining high levels of service. Gathering better data on routing will enable more accurate estimation of the number of vans needed, thus reducing the number of drivers, the area of largest expense. In addition, with such detailed data, partial insourcing based on routes could be evaluated.

With that said, unless the situation changes radically, a New England-based PACE emphatically should not insource any of the transportation if vendors are able to meet the target PMPM rates. Insourcing would be more expensive and less efficient because the site cannot dictate which member comes to the site at which time. They are scheduled based on need. This results in patients from various geographical regions coming to the site and requiring transportation to and fro. Because members are so dispersed it adds to the route time. If the existing policies were changed so that patients in one region come to the site on a specified day insourcing would be more feasible. The route times and cost would be a lot less because the
routes are essentially linear from site to end point. Another major component of cost is that NE PACE must pay drivers for a full day even when they are only needed for part of the day, so a specialty transportation vendor will have much higher staff utilization.

Insourcing is also not recommended at the moment because there is no existing infrastructure or relevant experience. To effectively create a transportation service, the foundation of the service must be developed extensively and this will take time and money. This combines with the higher than desired costs which are likely to continue to grow over time, to emphatically recommend against insourcing. Both vendor costs and customer service levels may change over time, which may create additional benefits for insourcing.
7. Works Cited

Journal Sources


Pantano, V.; O'Kane, P.; Smith, K., "Cluster-based Six Sigma Deployment in Small and Medium Sized Enterprises" Management of Innovation and Technology, (2006), 788-792


**Internet Sources**

"EIA Petroleum Navigator". DOE. 
(http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm)

http://www.whitehouse.gov/omb/circulars/a133/a133.html

Contract Center Analytics
“Contact Center Analytics: Driving efficiency, Higher Revenue, and Customer Satisfaction”
(http://www-03.ibm.com/solutions/businessolutions/oracle/doc/content/bin/ - Siebel_contact_center_March2005_4.pdf)

Grant Sources
(http://www.aoa.gov/about/legbudg/current_budg/state_allocations/T3_2004.pdf)
(http://www.whitehouse.gov/omb/circulars/a133_compliance/04/hhs.doc)

NEHP Biographical
(http://www._____.org/Extranet/_about/) (Sponsor Identity withheld by request)

MQP Design
“What is an MQP and Deisgn?” Department of Management, Worcester Polytechnic Institute 
(http://www.mgt.wpi.edu/Undergraduate/IE/mqp3.pdf)

National PACE 
(http://www.npaonline.org/website/article.asp?id=12)

New England PACE Benefits
(http://_____org/_____Our+Services/Benefit+Chart.htm) (Sponsor Identity withheld by request)

New England PACE
(http://______.org/_____/About+Us/Pace+Overview.htm) (Sponsor Identity withheld by request)

NIST Website
"What are the basic steps for developing an effective process model?". NIST. 
Appendix 1: Policies and Regulations

Policies have been separated into two sections for convenience. The first section deals with Drivers and Driver-Aides. The second section deals with the daily operations and maintenance of the vehicles.

Personnel Policies:

Procedures for Hiring Drivers and Driver-Aides:

1. Applicants must be screened to verify that they meet all requirements for the position.
   - Driver must have valid state drivers license and have an acceptable driving record as reviewed by hiring officer.
   - Driver must have completed Basic Life Support Training from an accredited program no more than two years prior to the date of the application.
   - Drive must have undergone a full physical examination no more than one year prior to the date of the application by a physician licensed to practice medicine.
   - Driver must have at least six months of documented frail participant care.

2. Applicants will be given three tests:
   - A driving test consisting of the applicant transporting a hiring director in the vehicle that he will be driving daily.
   - A test of the operations of the lifts and various other features of the vans.
   - A written test of the policies and procedures required to be a Driver/ Driver-Aides.

3. An applicant must possess qualities that are necessary for the position such as, patience, understanding, care, and responsible. The employee will be the face of a New England-based PACE program and as such, they must project a positive image of the program and the organization.
4. Applicants that successfully meet all the requirements and have passed the test will be given consideration for the position by the hiring director.

**Procedure for Drivers and Driver-Aides Training:**

Pass a written test covering organization guidelines for driving, knowledge of service area, local and state laws applicable to driving specified vehicles, and general information regarding the vehicle.

Trainees should complete vehicle training with an experienced passenger van driver. Initially, driving should take place in a suitable closed area. Only after the experienced driver feels that the candidate is able to handle the vehicle properly, should they be permitted to operate on public roadways. The candidate should train on all different types of roads within the service area including residential roads, commercial area and limited access highways if they are present.

Pass a final road test, which should include turning, backing, distance and clearance judgment, braking, parking, turn around and operations on any special roadway specific to the service area.

**Procedures for Drivers and Driver-Aides Training:**

1. **Route Knowledge**
   
   a. Maps of the routes an employee will drive will be given.
   
   b. Employee will be given one week to practice and memorize these routes.
   
   c. A test in the form of the employee driving the route without the aid of any electronic device will be given by a staff of the hiring team.

2. **Procedure Knowledge**
   
   a. All procedures and policies will be given to the employee.
b. The employee will be given two weeks to learn and memorize these policies and procedures.

c. A written test will be given at the end of the allotted time.

3. Vehicle Operations Knowledge

a. An employee with knowledge and experience of the vehicle’s operations will be assigned to the trainee.

b. The purpose of the employee and trainee relationship is that of a mentor.

c. The employee will show the trainee basic operations required of the vehicle, such as, operation of the lifts, safety restraints, etc…

d. The trainee will be allotted one week to familiarize himself with the operations of the vehicle.

**Procedures for Shift Scheduling:**

1. Each driver will be assigned 4 days of work each week.

2. 20% or 2 drivers, whichever is greater, must be off duty each day. This is to assure that there will always be a replacement driver.

3. Driver will be given a fixed amount of sick days. This must be accounted for while scheduling a shift only if the employee indicated the time in advance.

**Procedure for Drivers and Driver-Aides Absenteeism:**

If for some reason a driver cannot attend work at an assigned time he is responsible for notifying the PACE center immediately so that a replacement driver may be found. The following actions must occur:

1. In the event that a driver does not report one hour prior to the first daily trip an alternate driver / driver-aide will need to be called upon.
2. In the event an alternate driver or driver aide cannot be reached, it is the responsibility of the transportation coordinator to schedule a special trip request for the participants on that driver’s route.

3. If a driver does not notify the New England-based PACE program center within one hour of a missed shift, a log will go on the drivers file.

4. If a driver is absent / tardy without notice more than twice in a four-week period, the driver must schedule a meeting with the site director and personnel supervisor to discuss absenteeism.

5. In the event a driver does incur an absence / tardiness during the interim period between scheduling the meeting and the meeting date, the driver can be suspended immediately at the hiring officers discretion.

**Procedures for Driver-Aides Role Transitioning:**

A peak level of service has been noted for the operations of the PACE center. This procedure seeks to transition the employee in such a way that service level does not decline when needed. The transition from Driver to Aide and Aide to driver should increase capacity while not decreasing needed capacity in the other position.

1. During the morning shift; as soon as a driver has completed all of his routes, he will place the vehicle in the designated storage area and transition to the role of Aide.

2. During the afternoon shift; an aide will transition to driver 30 minutes before his first scheduled route departure time.
Vehicle/Operations Policies:

Procedure for Drivers and Driver-Aides Daily Responsibilities:

1. Inspect van at the beginning and ending of shift and report condition on van checklist.
2. Communicate with dispatch prior to every pickup and drop off of each participant.
3. Greet participants and center staff respectfully and courteously.
4. Speak clearly and audibly when giving instructions to participants.
5. Escort participants safely from specified pickup location to destination using personal protective device.
7. Sign participant transportation log during drop-off and pickup situations.
8. Report any changes in participant’s condition to respective New England-based PACE program personnel immediately.
9. In the event of an emergency notify transportation dispatcher immediately then document the event.
10. Ensure to follow safe driving practices.

Procedure for Safe Driving Practices for Drivers and Driver-Aides:

1. Ensure that participants are seated and belted before the vehicle is placed in motion.
   Releasing seat belts, while the vehicle is in motion is prohibited.
2. Persons other than participants should not be permitted to ride on vehicles.
3. Exterior lights should be used at all times when the vehicle is in motion.
4. Ensure to obey all traffic control signals, speed limits, and rules of the road of the jurisdiction involved.
5. The horn should be used in emergency situations only.
6. Refrain from aggressive driving.

7. In the event of inclement weather reduce speed and take precautions to provide the safest driving environment possible.

Van Checklist for Daily Vehicle Maintenance:

Date:

Vehicle Number:

License Number:

Mileage:

Fuel:

Interior Condition:

Exterior Condition:

Safety Equipment:

Comments:

Transportation Dispatching:

Should be managed by the center and should include a system of communication between dispatch and each vehicle in operation.